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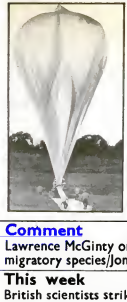

Ballooning offers a cheap alternative to the Space Shuttle for carrying scientific payloads into the upper atmosphere. On p 1072 a physicist from the Balloon Group at Southampton University describes some of the techniques that help to prolong high-altitude flights from Europe to the United States.

Cover by: Chris Butler

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Comment

Scientists reticent

When the General and Municipal Workers Union (GMWU) decided to organise a series of seminars on cancer in the workplace—a thoroughly commendable idea—it tried hard to find British scientists to address the three meetings it planned. The GMWU is one of the few British trade unions to have a safety officer and there are clear signs that it intends to campaign vigorously for stricter control of carcinogens in the workplace (see p 1068). Such a campaign is much overdue—too long have trade unions been content merely to win compensation for their members disabled or debilitated by exposure to chemicals at work, leaving the more political problem of controlling carcinogens to "the experts". This abdication of responsibility left the Health and Safety Executive (HSE), which has responsibility for controlling carcinogens at work, at the mercy of the chemical industry.

Scientists unconnected with the chemical industry might therefore be expected to leap at the opportunity to help the GMWU to develop its campaign. But the union could not find a single British scientist of stature willing and able to give any of the three seminars it was organising. Instead, it invited Bruce Ames from California to talk about short-term testing for carcinogens and last week it paid for Sam Epstein to fly from Illinois to the second of its seminars (held jointly with the Association of Scientific Technical and Managerial Staffs). Epstein is a leading member of a group of scientists in the US which, in the past five years or so, has put its expertise at the service of trade unions and public interest groups campaigning for tighter control of carcinogens (and other dangerous chemicals).

Could it be that scientists in Britain are not happy to be linked—financially and otherwise—to the chemical industry, an industry which, as Epstein has detailed in his book *The Politics of Cancer* has deliberately destroyed, distorted and suppressed inconvenient research findings? Outspoken criticism on environmental issues has certainly cost some scientists advancement and recognition in their fields. The platform and political protection that campaigns such as the GMWU's provide for scientists may not be ideal—trade unions are not above criticism. But at least it is a platform.

Lawrence McGinty

Fishy success

The "Conference to conclude a Convention on the Conservation of Migratory Species of Wild Animals", which started on 11 June in Bonn just managed to complete its work in time for the signing of the convention, at midday on 23 June, by 22 out of the 50 nations still present.

The original draft convention was prepared by the International Union for the Conservation of Nature and Natural Resources, and subsequently taken over by the Federal Republic of Germany. The treaty demands that the parties "(a) should promote, cooperate in, or support research relating to migratory species; (b) shall endeavour to provide immediate protection for migratory species included in Appendix I; and (c) shall endeavour to include agreements covering the conservation and management of migratory species included in Appendix II". The first appendix lists endangered species, while the second catalogues those "migratory species which have an unfavourable conservation status and which require international agreement for their conservation and management."

A key issue at the conference was whether fish, whales, molluscs and other marine animals should be included. The overwhelming majority of delegates was adamant that such a global treaty should cover all species. Lesotho, Morocco, Sri Lanka, India, Togo and Chad were among a large number of extremely eloquent adherents to this principle—in fact, all the European, African and Asian nations except Japan were in support. However, a minority including the US, Japan, USSR, and South Africa, was clearly subject to political and economic pressures and wanted marine animals, particularly fish, excluded. But they were resoundingly beaten by 41 votes to 9.

It remains to be seen whether the US really is as implacable as it claimed, and whether the conservation body can exert enough influence to persuade it to sign the convention. Meanwhile the most significant effect of it not signing now will be cash. The US would no doubt have contributed substantially to any budget if it had become a party. But the conservationists represented as observers at the conference were unanimous in their support for the hard line adopted by the majority of delegates, and saw this treaty as the most significant step forward since the coming into force of the Convention on International Trade in Endangered Species of Wild Fauna and Flora.

John A. Burton
Fauna Preservation Society

Black figures, white lies

Last week the Office of Population Censuses and Surveys (OPCS) brought out a mucky little report on the growth of Britain's Black population, purporting to make reasonable projections up to 1991. It seems to suggest that (compared with 1976) the Black population will have increased by about 50 per cent, or (on higher assumptions) by nearly 80 per cent. However, as soon as one pries under the surface of the forecast, the precision of the numbers begins to dissolve. Take the prediction of future fertility rates, for example. Those for West Indians, Indians, Pakistanis, and the remainder, are combined into a single figure by weighting them by the relative size of their respective populations. Fine—except that the relevant numbers should be those of women of child-bearing age, not of the whole population.

Nevertheless, the main case against the report does not rest on statistical quibbles, but on the fact that there are no "facts" on the way in which these "non-facts" are presented. It contains a plethora of what OPCS itself describes as "assumptions", or even "arbitrary assumptions". Occasionally they become "highly speculative", or for "illustrative purposes only".

The problems are compounded by the way the figures are presented. The "high" and "low" assumptions for both fertility rates and immigration are analysed in combination. The differences between the four resulting projections seem to suggest that immigration makes a much larger contribution to population growth than does natural increase. This, however, is a result of selecting for study widely differing assumptions on migration, together with alternative fertility assumptions which have relatively little differential impact. A more major presentation of distortion comes from the OPCS's focus on the Black population exclusively, rather than in context. Considerable increases will undoubtedly occur, as this sub-population's age structure, skewed towards growth, adjusts. But presenting such developments in terms of proportionate increases in what is still a very small fraction of the total population invites ill-informed or malicious mis-use.

Jonathan Rosenhead

This week

Stalemate and confusion in scientists' strike

Lawrence McGinty

At the end of a week of selective strikes there seems no prospect of a settlement of the pay dispute between government scientists and their employer, the Civil Service Department (CSD).

This week, IPCS started a campaign of selective strikes—calling out 64 members in the professional and technical grades in three Ministry of Defence munitions establishments. Its 18 000 scientist members and the remaining 50 000 professional and technical officers (PTOs) are working to rule.

As the views of the two sides harden, the circumstances of the dispute become more and more confused. Two groups of civil servants are involved—the scientists and the professional and technical officers.

The government has offered PTOs a 15 per cent pay rise, basing this on the median earnings of comparable engineers, architects and quantity surveyors in private industry. But IPCS claims that, in the past PTOs have been offered rises based not on median earnings, but on the earnings of the best-paid engineers outside the civil service. The CSD wants the dispute to go to arbitration, but IPCS refuses, saying that it is impossible to arbitrate on principle.

The dispute over scientists' pay is even more difficult to fathom. Originally, CSD offered the scientists the same increase as PTOs, while giving administrative grades in the civil service an increase of 25-35 per cent. But a week last Friday Paul Channon, the Minister for the CSD, offered government scientists the same increase as administrators. However, he insisted that this offer was conditional on IPCS accepting that it would not set a precedent—either for PTOs or for the 1980 pay negotiations. The IPCS objected to the wording which embodied this condition.

In 1980, scientists' pay increases will be determined through the pay review procedure—the same comparison exercise now used to fix the salaries of all other civil servants including PTOs. IPCS claimed that the wording of the conditions to CSD's offer would prevent it negotiating the kind of upward adjustment to increases that PTOs had enjoyed in the past. It offered CSD an alternative wording for the crucial condition attached to the proposed agreement.

On Tuesday last week, Channon laid a formal offer on the table. The wording of this is almost identical to that which the IPCS suggested the week before. But IPCS refused to agree to the new wording because it referred to the original conditions which IPCS had rejected.

Many of these exchanges between CSD and IPCS were in confidential "without prejudice" discussions. But CSD circulated copies of documents discussed at confidential meetings to government departments "quite contrary", according to IPCS "to the agreement that CSD had entered into at its own request". CSD also gave journalists, including *New Scientist*, copies of the confidential documents. On Tuesday Bill McCall, IPCS's general secretary, accused CSD of mischievously using the confidential documents as "an exercise in trickery and deception". He has refused to participate in further "without prejudice" discussions and has released records of all previous confidential exchanges. □

Roi Herman

Forensic work came to an abrupt halt when British scientists at the Laboratory of the Government Chemist went on strike last Friday

"He won't touch his pedals unless we increase his reward by 30 per cent."

US leans towards slim science budget

The White House has already completed its preliminary plans for the 1981 federal budget, to be presented to Congress next January. From the clues given at the annual meeting of the American Association for the Advancement of Science on R&D (see also p 1069) by Bowman Cutter, one of President Carter's senior financial planners, it will be a virtual replay of the "lean and austere" 1980 budget. There will be small cuts in most programmes but some real growth in basic research funds.

The economic uncertainty this year "is greater than at any time in the history of this administration," said Cutter who is executive associate director of the Office of Management and Budget (OMB), "so we have told the President we think he has to delay final judgements about the 1981 budget until the last possible moment [early December]". Whatever happens, though, the lid will be kept firmly on government expenditure—any concessions would take the form of tax cuts, rather than more federal spending. But Cutter did state clearly that there will be "a modest amount of real growth in basic research funding".

Unfortunately, as the White House plans its modest boost for basic science in 1981, the growth in research funds proposed last January in the 1980 budget is rapidly evaporating under the combined effects of double-digit inflation and Congressional budget-cutting. The inflation rates assumed in the President's budget documents—about 7 per cent for 1979 and 1980—are clearly going to be at least two points too low. And although there are three months to go before Congress completes its byzantine budget process for 1980, the axemen in the House of Representatives' Appropriations Committee have already made their mark on the President's request.

For example, the committee has recommended a $19 million cut from the National Science Foundation's budget request, leaving it with an increase of 8·3 per cent rather than 10·4 per cent. The recommended appropriation for basic energy research is $213 million—an increase of $25 million, rather than the $50 million proposed by Carter. The committee felt the latter, coming on top of previous big increases, may be reaching the point of diminishing returns. But the National Institutes of Health, always the darling of Congress, is given an additional $203 million. The administration didn't want to increase the $3·2 billion NIH budget at all because it has done so well in the past. □

This week
continued

Flights of fancy for Europe's space programme

Anatol Johansen, Paris

Europe's own space rocket, the Ariane launcher, could eventually be "stretched" to such an extent that it would be possible to have a European manned spaceflight programme. This is the conclusion of a study carried out by the French Aerospatial company for the country's space agency, the Centre Nationales d'Etudes Spatiale (CNES).

The first Ariane, which has been built by a consortium led by Aerospatial and is due to be launched in November, can put a payload of only 1·7 tonnes into a transfer orbit, or 1 tonne into a geostationary orbit. However, Aerospatial and the European Space Agency (ESA), the organisation in charge of the Ariane programme, have already studied a number of stretched versions of the rocket (*New Scientist*, 19 April, p 180); but the latest study is the first to suggest, albeit very tentatively, that ESA could one day send people into space.

Today's Ariane rockets are 47 metres high and weigh 208 tonnes. The first improved version, Ariane 2, would have an extra 1·25 metres added to its third stage to increase the fuel load from eight to ten tonnes of liquid oxygen and hydrogen. Ariane's transfer orbit payload would rise to 2 tonnes.

If ESA adds two solid boosters to Ariane 2 it would get Ariane 3. This vehicle could, according to Gerard Leroy of Aerospatial's missile and space division, be ready for launching in 1983. Ariane 3 would carry 2·3 tonnes into a transfer orbit. Leroy believes that the cost of going to Ariane 2 and 3 would be no more than 10 per cent of the £500 million or so cost of the Ariane 1 programme.

Ariane 1, due for its first launch in November, could be the forerunner of a family of European rockets culminating in a manned spaceflight programme

Although the first two stretched rockets would be something like 2 metres longer than the first launchers, they could be accommodated on the existing launch pad at Kourou in French Guiana. But going on to Ariane 4 would require the construction of a new launch pad, and this is where the launcher improvement programme would become more expensive.

Ariane 4 would have its first stage stretched by 3 metres to increase its fuel load from 140 tonnes to 200 tonnes, increasing the launchers' carrying capability so that it could take 3 tonnes into a transfer orbit. Leroy estimates that it could cost £40 million to develop Ariane 4, which could be ready to go into orbit in the mid-1980s.

The big leap forward, however, would come with Ariane 5. Compared to Ariane 1 this would be an almost completely new rocket. It could use the improved first stage built for Ariane 4, but even this might not be big enough. In any case it wouldn't be possible to use Ariane 4's second and third stages. Instead of these two stages a single stage burning 50 tonnes of liquid oxygen with a thrust of some 80 tonnes would have to be built. Ariane 5 would need a new rocket engine, too. The payload diameter would be increased from 3·2 metres—the size for Ariane 1—to 4·7 metres. This would give the launcher a payload volume of 170 cubic metres—half as much as the US's Space Shuttle.

Ariane 5 would weigh more than 300 tonnes and would carry about 10 tonnes into a low orbit some 800 kilometres above the Earth—alternatively it could take 4·75 tonnes into a transfer orbit. (There are different versions of Ariane 5 under investigation: the 10 tonne version would be the most powerful.)

Although Pierre Usunier, head of Aerospatial's missile and space division, calls it "a rather vague possibility", Ariane 5 is clearly meant for manned space flight. Aerospatial is already studying the possibility of building an unmanned space station, called Minos, for automatic materials processing in space and other technological research, as well as a "mini-shuttle" called Hermes that would be capable of carrying five astronauts or two astronauts and 1·5 tonnes of freight.

The tremendous costs of Ariane 5 as well as those of Minos and Hermes could block Europe's entrance into manned space flight. Cost estimates put the price of Ariane 5 at something like £1000 million, and £1200 million for Hermes. Together with the automated space laboratory and the usual cost overruns, the total cost could be over £3000 million. However, this is still a lot less than the £10 000 million that Italy, West Germany and the UK are spending on the Tornado multi-role combat aircraft. □

Unsafe at any workplace?

One of the most significant British meetings for some years in the field of health and safety took place recently. Two unions—the General and Municipal Workers Union (GMWU) and the Association of Scientific, Technical and Managerial Staffs (ASTMS)—organised the meeting, at which Professor Sam Epstein of Illinois University addressed scientists and union officials on "the politics of cancer".

The meeting is highly significant for two reasons. First, it is a clear sign that trade unions are beginning to campaign on the issue of occupational cancer. At a press conference before Epstein's seminar, David Basnett, general secretary of the GMWU, talked of mounting "a campaign of awareness on this issue—building up a political opinion on this matter which will ensure that countermeasures are taken". ASTMS's general secretary, Clive Jenkins, also attended the press conference, where it became known that ASTMS is to expand its health and safety department by employing a researcher—the first position of its kind in a British trade union.

Epstein's seminar was the second in a series of three meetings on occupational cancer organised primarily by the GMWU. The first was given by Californian scientist Bruce Ames, who developed the test that now bears his name for spotting potential cancer-causing chemicals, and a US scientist will probably give the third. This preponderance of US scientists indicates, as British-born Epstein pointed out, that scientists in the UK who are willing to speak out on the unions' side are few and far between.

Epstein was certainly outspoken at his seminar. He claimed that cancer is reaching epidemic proportions (claiming 2 per cent more victims every year) and that the best scientific estimate is that 40 per cent of these deaths will be caused by exposures to chemicals at work. He said that the chemical industry "has a stranglehold on the whole process of generating and assessing scientific data" about these chemicals and has used this monopoly to manipulate, destroy, distort and suppress data unfavourable to its products. This, he says, is "a massive, well orchestrated conspiracy to prevent regulation to protect the worker and consumer" against cancer-causing chemicals. Further, "the overwhelming pressure, power and lobbying of the chemical industry is not balanced by other lobbies—a massive social imbalance" amounting to a "distortion of decision-making by special interest groups". □

US Senate vote sinks Third World institute

Clive Cookson, Washington DC

The timing of the session on the US's international research and development policy at the annual meeting of the American Association for the Advancement of Science on R&D was very unfortunate. The day before, the Senate had voted against President Carter's plan to set up an Institute for Scientific and Technological Cooperation (ISTC) within a reorganised US foreign aid structure. As the basic idea of the ISTC —if not the precise details of the President's proposals—was supported almost unanimously by the science policymakers at the meeting, the unexpected Senate rejection cast a definite pall over the proceedings.

Not that the ISTC is necessarily dead. In April the House of Representatives defeated by 236 votes to 156 a similar attempt to eliminate the institute from the foreign aid reorganisation bill, so the Senate will now have to go into conference with the House to reconcile the two versions of the legislation. Therefore most speakers at the colloquium pleaded with their audience to lobby Congress to save the ISTC, which they see as an essential move away from the paternalistic and often incompetently managed scientific and technical programmes of the Agency for International Development (AID) towards a genuinely cooperative approach.

"Unfortunately the record of AID in this area has been deplorable," said Charles Dennison, executive director of the Council on Science and Technology for Development (which has emerged as the leading non-governmental think-tank in the field). His council has quarrelled with the administration's approach to the ISTC, on the grounds that the Institute was not being given sufficient independence from the rest of the federal bureaucracy, but now that the idea is in danger of being lost altogether he has rallied to its defence.

The rhetoric of the senators who voted to kill the ISTC shows that they did so, not because they disagreed with its goals, but as a reflex action against the creation of yet another government agency. There also seemed to be a disturbing anti-science sentiment. Democratic Senator Dennis Deconcini, author of the killer amendment, told his colleagues the institute would create "another layer of expense, with more bureaucracy, well-paid bureaucrats, another facility to interact with scholarly endeavours of an elite group of social and other scientists in the United States and within the underdeveloped countries. The present programme seems to have a great deal in common with the United Nations University, which the Senate on three separate occasions has soundly rejected [funding]."

The Senate's feelings against the ISTC were strengthened by two long articles in the *Washington Post* last week, giving details of alleged financial waste and mismanagement throughout the United Nations. Although the new institute would have nothing to do with the UN, its opponents managed to argue that because the United State's contributions to the UN's development and aid programmes are being wasted, President Carter should, in the words of Republican Senator Bob Dole, "tighten up on such misuse of our foreign assistance dollar before we start finding new ways to spend it".

Thomas Pickering, director of the State Department's Bureau of Oceans and International Environmental and Scientific Affairs, also expressed dismay at the Senate vote, which he called "a sign of the times". He cited several other recent instances of Congress's hostility to expenditure on international scientific cooperation; there have been strong efforts over the past months to remove the US contribution to the United Nations' technical programmes; the administration is in trouble with its request for $7 million to set up a bilateral research foundation with Yugoslavia; and of most direct interest to Pickering, a House of Representatives appropriations subcommittee voted last month to cut the 1980 budget of his own bureau from $6 million to $3 million.

Marcelo Alonso, director of scientific affairs for the Organisation of American States, put the ISTC into financial perspective when he called international science "the peanut component" of American R&D. "The ISTC is a very welcome idea, but we must realise that we're just talking about $100 million," he pointed out. Only $25 million of the institute's proposed $100 million budget would actually be new money—the rest represents programmes to be transferred from AID.

But according to Robert Morgan, chairman of the Technology and Human Affairs Department at Washington University, the great promise of the ISTC lies in the fact that its establishment would, for the first time, give the US a specific legislative mandate to assist less developed countries to build up their scientific and technological infra structure. That mandate would be more significant than the institute itself, or the size of its budget, said Morgan, the author of two important studies for the forthcoming UN Conference on Science and Technology for Development (UNCSTD). □

US breathes fresh air into government regulations

Over the past decade growth of American industry has been slower than all its main competitors (except Britain), and the growing jungle of federal regulations, allegedly stifling efficiency and innovation, is taking a lot of the blame. So it was not surprising that the two main White House speakers at the annual AAAS colloquium on R&D policy focused on the need to improve regulatory policy. Both Frank Press, the President's Science Adviser, and Bowman Cutter, his Executive Associate Director for Budget, admitted freely that Washington's regulatory system requires big changes—not necessarily in the direction of less regulation, as their critics in industry contend, but towards a much more centralised, better coordinated structure.

"One of the most striking changes that has taken place in our federal government over the past 15 or 20 years has been the rapid growth of 'social' regulation, that is regulation to control corporate or individual behaviour to achieve some socially desired objective that we would not expect our economic system to attain otherwise," Press said. Social regulation is quite different from the old-fashioned economic regulation of monopolistic industries like transport, telecommunications, and energy supply, and it is often heavily technological, as for example in environmental and health and safety regulations. (Pollution control alone is now taking two to two-and-a-half per cent of the US gross national product, about $40 billion a year, according to the Council on Environmental Quality's latest annual report.)

The total effect was summarised by Press as "A regulatory structure which is highly segmented, wide-ranging in its impact, economically important, highly politicised, very aggressive, relatively independent [of Congress] and almost totally uncoordinated". President Carter has already taken several steps to "rationalise" the structure. He has:

- required agencies to publish "regulatory analyses to ensure that the regulators and general public are well informed about the costs and benefits of individual regulations".
- created a regulatory council, representing all the regulatory agencies, which is supposed to bring in some coordination and consistency to their rules
- set up a regulatory analysis review group (RARG) in the White House to review 15 to 20 major regulations a year.

RARG is intended, in Frank Press's words, "to improve the quality of regulatory analyses by ensuring that the most important get a thorough review, and alternative points of view are considered by regulatory officials". But many of the latter and their supporters feel that it's unduly dominated by White House economists with a doctrinaire anti-regulation attitude and a tendency to meddle illegally.

Cutter implied that the Office of Management and Budget was hoping to take a central role in the emerging new regulatory order. Indeed it seems that OMB sees a grand future for itself as a centralised resource planning agency. The transformation might take ten years, Cutter speculated. □

This week
continued

Computer sleuth tracks down baby disease

Computer analysis of babies' first cries may provide a reliable, cheap screening method for a wide variety of postnatal ailments, ranging from jaundice to the so-called infant sudden death syndrome. An American engineer and doctor have collaborated to develop a computer model of healthy newborn babies' cries and, by comparing the model with computer profiles of recordings of other babies, claim to be able to pick out those already sick by their cries alone.

Michael Corwin, a paediatrics resident at Upstate Medical Center, Syracuse, New York, and Howard L. Golub, a biomedical engineer at the Massachusetts Institute of Technology, presented their startling findings at the 50th anniversary meeting of the Acoustical Society of America, recently held at MIT.

In order to prepare the computer model, Golub tape-recorded the cries of 55 healthy babies when they were pricked in the heel at the age of 2 to 4 days. This is routinely done to obtain blood for testing for the disorder known as phenylketonuria or PKU. He broke down the sounds into 88 components, including such variables as pitch and intensity. But to complete the model he took into account how adults make sounds, and allowed for the different anatomy and physiology of infants.

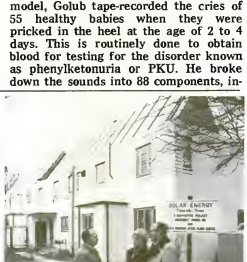
Computerised versions of the cries of the original 55 healthy babies and 43 others with known or suspected disabilities were then compared with the model. The comparison identified 19 to 21 babies ill with jaundice, and 9 of 10 babies suffering from respiratory distress.

Golub and Corwin expect to refine the method to be able to pick up other abnormalities, such as some forms of brain damage, bacterial meningitis, and deafness. Even babies vulnerable to the mysterious sudden infant death syndrome may have distinctive cries which will give a clue to some anatomical deformity that made their cries distinctive, and then led to suffocation. □

Carter rises over US solar power

Using the symbolism of the dedication of a White House solar water heating system President Jimmy Carter last week announced plans for a steady increase in US use of solar power. The first stage will be the creation of a $100 million solar energy bank intended to increase the proportion of US energy derived directly or indirectly from the Sun to 20 per cent by the year 2000, contrasted with the current 5 per cent.

Beyond the solar bank which will be financed, according to administration plans, by the windfall profits tax that Carter hopes to win from Congress as part of his oil deregulation scheme, the new plan offers other concrete steps towards a stronger solar economy. (The windfall profits tax would recover for the US government some of the extra money the oil companies will make if the oil they produce in the US is sold at world prices rather than the lower regulated price that now prevails.) They include a 15 per cent investment tax credit for industries who use solar power to generate heat; a 20 per cent tax credit for new homes using built-in solar heating equipment; a 15 per cent tax credit for purchase and installation of airtight woodburning stoves—which use solar power indirectly as a result of the role of sunlight in the growth of trees; and an exemption from federal petrol taxes for gasohol, the mixture of petrol and alcohol.



A NASA solar home, which may save up to 50 per cent on fuel

Administration officials estimate that only about one-third of the 20 per cent contribution planned for solar power in the year 2000 will derive from the direct use of the Sun in solar heaters and air conditioners. The rest will come from hydroelectric power, wind power, the conversion of waste products, biomass, and other renewable resources. □

Anti-radar revolt gathers speed

The recent decision by Miami Judge Nesbitt to overrule radar evidence in a string of car speeding cases (*New Scientist*, 17 May, p 526) has started an anti-radar revolution in the US. The Miami courthouse is inundated with more than 50 requests a day for copies of Judge Nesbitt's ruling. Several hundred requests have been received from other local US courts and already judges in North Carolina and Fort Lauderdale, Florida, have adopted Nesbitt's ruling.

Electrolert, manufacturer of the aptly named Fuzz Buster police radar detector, spent $20 000 on the Miami test case, and is offering to supply trial transcripts at a nominal cost to lawyers defending speeding cases backed by police radar evidence. Electrolert is also threatening a million dollar advertising campaign to capitalise on the public's new-found awareness that police radar makes mistakes.

The public is already receptive to such a campaign because it is estimated that the media has made 300 million citizens familiar with the Miami decision, and US judges currently hand down 28 000 speeding convictions every day. Already 1·25 million motorists have police radar detectors fitted to their cars to gain advance warning of police radar traps.

An appeal has now been lodged against a recent decision in the state of Michigan upholding a 50-year-old law which prohibits radar detectors in private cars. As at least 75 000 motorists in Michigan are known to have bought radar detectors, and under the present law Michigan police are entitled to arrest them all, the outcome of the new appeal could have implications even more far-reaching than the Miami trial. □

SRC pushes energy conservation

Britain's academics should direct more of their research towards methods of conserving energy and materials in industrial processes. This is the conclusion of a Science Research Council report (*Making the Most of Materials*, free) which announces a five-fold increase in the research funds made available in these areas. The funds have increased from £50 000 in 1977/78 to almost £250 000 in the current academic year. Figures for 1979/80 will be known in the autumn, when budget cuts in research have been worked out.

The SRC's 183-page report examines a wide range of industries which involve materials processing. They include metals casting and smelting, paper and board manufacturing, and the rubber and plastics, ceramics and glass industries.

The report states: "The SRC wishes to encourage research into more efficient production routes and more efficient use of existing materials as well as research into new materials, the introduction of which could reduce both energy usage and the dependence on potentially scarce materials."

The SRC says academics participating in the programme will have to develop closer links with industry. "The success of this initiative will be markedly dependent on a more closely integrated partnership between university and polytechnic departments and industry, and wider applications of an engineering philosophy in universities. University departments should concentrate on . . . areas of national need."

The report gives several examples of research which could benefit materials conservation. Among these are: work on increasing the yields of products in several stages of a processing chain; studies into decreasing energy expenditure at key points in energy-intensive processes; and shifting R&D to emphasise materials which can be recycled. □

Prestel's fortune-teller

When the cinema and television first appeared, most people had a very limited idea of what these inventions could make possible. Few of the early cinemagoers who watched the "silent movies" would have dreamed of *Star Wars*. And who among the first TV news readers would have looked ahead to the era of satellite broadcasts and electronic news gathering?

These are points that Alex Reid, the director of the British Post Office's Prestel viewdata system, likes to make. Viewdata is the generic name for equipment that calls up information via the telephone system onto a domestic TV screen. The Post Office is the first organisation in the world to offer a public viewdata service. Reid believes he is supervising the start of a new form of communications with almost unlimited possibilities; however, remembering the caution with which the first films and TV programmes were greeted, he doesn't expect the whole world to agree with him.

Reid is a tall, lean man of 38 who has a lot of nervous energy: most of this finds an outlet in an enormous enthusiasm for Prestel. He believes that if Prestel is to succeed it must be fun. "I like to draw an analogy with the motor car. One of the reasons that this was a success was that the early cars were useful *and* people liked driving them." As though to prove the point, Reid confesses that he sometimes spends his weekends writing limericks which he puts into Prestel computers for people to "call up" on their TVs.

Directors of computerised information services for the public are today rather thin on the ground. (Of course, in any future "communications society" there could be a lot more of them.) So career patterns for such people are by no means established. The steps which Reid took to his present job at first sight seem a little odd. He read architecture at Cambridge, and then became a helicopter pilot in the Royal Navy for five years.

When he left the navy, Reid's interest in architecture broadened out. He studied urban planning and the impact of telecommunications on work patterns. This was when he grew fascinated by ideas about how telecommunications could cut down on the need to travel. He worked on this subject for the Post Office for six years before becoming head of Prestel last year.

It is clear that Reid sees his job as similar to that of a publisher of a newspaper or magazine. Certainly he is more like a publisher than a head of one of the commercial "on-line" computer services which are now proliferating. The latter make available, again via the telephone system, dry facts of interest only to scientists and specialist groups of business people; but Reid sees his task as bringing a great variety of information to the world at large.

"Communication of information is a very important activity," he says. "But because of practical resource constraints, the traditional ways of communicating are becoming very expensive—look at the costs of printing and transport for instance."

Reid says that if the world enters the future armed with only the traditional methods of publishing—books, newspapers and so on—then the opportunities people have of expressing their views will decrease. On the other hand, electronic publishing along the lines of Prestel should become cheaper and easier because telecommunications costs are constantly falling.

There are several hurdles for Prestel to overcome before it becomes established. The main problem is a shortage of the specially modified TV sets which can receive Prestel. There are about 1000 sets installed, far fewer than the Post Office would like. The PO and the "information providers"—the 150 or so organisations which make available the different types of consumer and business information which is stored in Prestel computers—are pressing the TV set manufacturers to increase their output. The sets themselves are very expensive, at £1000 or more. It seems that prices must be reduced if Prestel is to be made attractive.

Another problem is that the PO's Prestel computer network is far from finished. This explains why the "public service" which began in March is so far limited to London households. (The bulk of Prestel sets belong to participants in a "market trial" who do not pay the full price for their sets.)

Probably the most vital question is how the public will respond to Prestel in the long run. This can be answered only when there are enough sets available from the manufacturers, and sufficient capacity on the computer network, for the Post Office to advertise its product in a big way. Reid, who would not be in his job if he were not an optimist, says that by the end of this year between 5000 and 10 000 sets will be in people's homes and offices. By the mid-1980s he plans for "several million". "This will certainly not be easy but this figure is achievable. The scope of the system is so enormous that it is possible for Prestel to find a place in society alongside, say, the TV and the postal services." As the backers of many previous innovations would no doubt tell him, Reid will have to wait a long time before he knows if he is right or wrong.

Peter Marsh

Seven Days

17 June to 23 June

17 JUNE The importance of peat in the energy crisis was highlighted by Allan Robertson, of the Macaulay Institute, Aberdeen, in Scotland, when he told a conference that peat in terms of "energy equivalent" is now four times cheaper than oil. The Scottish Peat and Land Development Association also heard Judith Hart, former Labour Minister for Overseas Development, comment that although there were vast deposits in the Third World, none of the British experts at Harwell and elsewhere was mentioning peat, despite the fact she had been responsible for putting "quite a chunk of money" into research into the development of alternative energy resources.

18 JUNE The US Supreme Court ruled, in a unanimous 9-0 verdict, that the federal government is fully within its rights to ban distribution of the controversial "cure" for cancer, laetrile, across state lines. This overturns the judgements of two lower courts, which had declared that federal laws on drug safety had no reasonable application in laetrile cases because the substance was used to treat cancer patients who would die anyway.

19 JUNE The UK's National Coal Board's subsidiary, IEA Services, announced in its annual report, that it will build up a computer-stored assessment of coal deposits throughout the world by 1982. The result will be a system identifying and quantifying the amount and quality of coal at most sites around the world.

19 JUNE An amendment to a US House of Representatives appropriations bill ordered the completion of the controversial Tellico Dam and Reservoir in Tennessee, which threatens the only habitat of a tiny minnow, the snail darter. The dam was almost complete, and had cost $109 million when environmentalists successfully blocked its construction under the terms of the Endangered Species Act.

20 JUNE Skylab was successfully manoeuvred into a slightly different position, to give operators on the ground more control over the re-entry of the doomed space station. A series of small jets shooting nitrogen turned the vehicle 90 degrees, so that it offers more resistance to the atmosphere but is less affected by gravity. If ground controllers find the day before re-entry that the debris will fall over a heavily populated area, then theoretically it is now possible to rotate Skylab another 90 degrees so that it will orbit two or three more times around the Earth, shifting re-entry to a less populour area.

THE NEW SCIENTIST 20 years ago

Recently the House of Lords had a great deal of fun in questioning Lord Hailsham about the legal problems which the exploration of space will throw up. With imperturbable calm the Lord President of the Council declined to recognise a "prima facie sovereignty" over the Moon or any other heavenly body which may be thought to have been established by the flight of space rockets.

The New Scientist, 23 June, 1959.

Transatlantic ballooning

Scientists have developed self-ballasting balloons which can carry scientific instruments in the upper atmosphere for several days and so provide an inexpensive way to study outer space

Dr David Ramsden is with the Department of Physics at Southampton University

Our knowledge of the Universe is to a large extent based on observations made in a relatively narrow part of the electromagnetic spectrum. Although the Earth's atmosphere acts as a shield against the harmful radiations from the Sun, it also obstructs some astronomical observations. In the past, observations were limited to a narrow range of wavelengths which can penetrate this atmospheric barrier in the visible and the radio part of the spectrum.

Just as advances in radio astronomy were possible because of the technical developments in radar in the 1940s, progress in other areas of astronomy had to await the development of the more sophisticated space technology. With the advent of rockets, satellites and stratospheric balloons, valuable observations are now possible in the hitherto inaccessible regions of the spectrum, using instruments carried above the obscuring layer of the atmosphere (see, for example, *New Scientist*, 12 April, p 104).

Satellites are useful because of their long working lifetimes, which make it possible to carry out sky surveys and to study changes in the energy output of different sources over a long period of time. But the payload of a satellite is severely limited, and the cost of putting each kilogram into orbit is high. So balloons, with their capacity to carry a massive payload into the high atmosphere cheaply are still very much workhorses for observational astronomers. In the 1950s, payloads weighing 300 kg flown in balloons with volumes up to 100 000 cu.m (about 30 m in diameter) were typical; today, balloons ten times larger are commonly used to carry a tonne or two of instruments to altitudes of 40 km or more. Even the Space Shuttle will not be able to compete, in terms of cost per kilogram, as a means of carrying instruments to the edge of space.

But there is a snag with balloons—they drift away from the ground stations used to launch and monitor them, carried by the strong winds in the upper atmosphere. So at present there are certain areas of research where balloons cannot compete in providing the long observation periods which are possible with satellites. In addition, although at 40 km altitude all but 0·3 per cent of the atmosphere is below the balloon, some experiments must be flown above the atmosphere to be effective. Nevertheless, any way of extending the effective life of a flight provides real benefits in terms of more data at the same cost.

Facilities for launches

During the 1960s, central facilities for balloon launches were developed at locations such as the National Scientific Balloon Facility in Palestine, Texas, and by CNES (Centre Nationale Etudes Spatiale) at Aire l'Adour in France. Scientists from many institutions in many countries use these facilities, and obtain flight times of 8 to 10 hours.

The length of flight possible with such a facility varies. For most experimenters the value of an observation would be significantly improved if the exposure could be increased. Some experiments benefit simply in proportion to the flight length. These include the study of rare or sporadic events such as solar flares or gamma-ray bursts, where a flight lasting twice as long doubles the chance of observing a flare. In other experiments a long flight is valuable simply for a survey of a large part of the sky during a single flight, or to monitor fluctuations in one particular source over several days. Extending the duration of a balloon flight can achieve a much better scientific return on the money invested in the balloon necessary to lift the instruments to the required altitude.

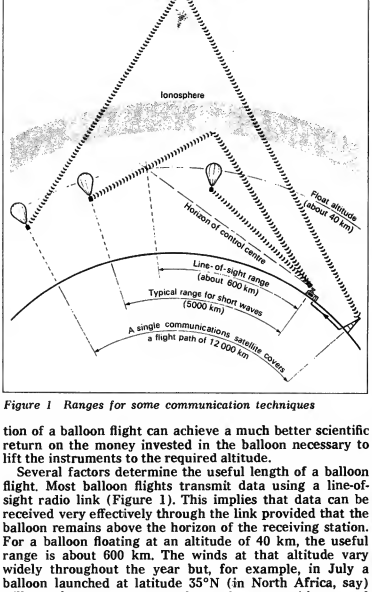


Figure 1 Ranges for some communication techniques

Several factors determine the useful length of a balloon flight. Most balloon flights transmit data using a line-of-sight radio link (Figure 1). This implies that data can be received very effectively through the link provided that the balloon remains above the horizon of the receiving station. For a balloon floating at an altitude of 40 km, the useful range is about 600 km. The winds at that altitude vary widely throughout the year but, for example, in July a balloon launched at latitude 35°N (in North Africa, say) will, on the average, move almost due west with a speed of 80 km/h. Useful data can therefore be received from the balloon for only about 8 h, unless extra ground stations are spread along the expected trajectory at, for example, 1000 km intervals.

Data could, alternatively, be transmitted using a short-wave transmitter. The signal must be reflected from the ionosphere to communicate over the horizon. While long-range communications are possible in this way, technical difficulties severely limit the quality of the link. The rate of data transmissions is generally only a small fraction of that capable of being transmitted via a line-of-sight link.

A third possibility is to make use of a communications satellite to relay the data back to the control centre. Recent developments make this an attractive route to follow, but so far, it has been achieved with only relatively low data rates. Principally because of these communications problems, long balloon flights are limited to brief periods in May and September when the winds are very light. Flights lasting a few days have been achieved during

these periods but naturally they are popular times and the facilities are often over-extended.

Another serious limitation to the length of a flight is the balloon itself. The large polythene balloons which have proved to be so useful, are constructed in such a way that when they reach float altitude, any excess gas vents away into the atmosphere. This minimises stresses in the balloon skin and ensures that a lightweight fabric can be used. During the daytime, the balloon absorbs some of the solar radiation and becomes warmer than the surrounding atmosphere. At sunset, the gas in the balloon cools and consequently the volume of the balloon shrinks. The net result is that the balloon loses altitude, soon sinking too low to be of value to the balloon scientists. To maintain a good, high, float altitude at night, it is necessary to reduce the gross weight of the balloon system by about 8 per cent each night. The ballast requirements for four sunsets would amount, typically, to 750 kg.

Light but strong

This disadvantage of these so-called zero pressure balloons has been recognised for some time and efforts were made over several years to build a super-pressure balloon system capable of reaching 40 km with a useful scientific payload. In this type of system the balloon is sealed and the fabric has to be strong enough to withstand the balloon being pressurised to a level some 15 per cent above the pressure at float altitude. This ensures that the balloon will remain fully inflated, even at night, when the gas cools, but poses problems in the design and fabrication of a balloon which is both light enough and strong enough. Scientists in the US have devoted much effort to achieving this goal, but have not yet reached the target.

The balloon group at Southampton University has made an effort to extend the score of long duration balloon flights on a routine basis. We started in 1974 from the idea that conventional zero-pressure balloons might be flown right across the Atlantic Ocean during the summer months when the high altitude winds consistently blow almost directly westward. These winds would carry the balloon across the Atlantic in four to eight days and the predicted north-south drifts are such that there would be very little chance of the balloon failing to reach the US.

A substantial part of the lift capability of the balloon would need to be used for ballast for release each evening. Even so, our calculations showed that experiments weighing about 500 kg could be maintained at altitudes of 40 km for periods of between 4 and 6 days. For some types of experiment this represents an opportunity comparable in value to that offered by the Space Shuttle but at a tiny fraction of its cost.

To be effective, the technique depends on two things: first, keeping the balloon aloft (and recovering it in due course), and, secondly, maintaining communication with the scientific payload throughout the flight. We decided to tackle the ballooning problems first, and to worry about the communications in detail once the transatlantic ballooning technique had been proved in practice. We needed an automatic altitude control system which would dispense ballast as necessary in as conservative a way as possible, while being flexible enough in use to accommodate different experiments with different altitude requirements. The greater the degree of stability demanded, the higher would be the rate of consumption of the ballast reserves.

Our automatic system measures the rate of descent of the balloon over a period of 14·1 minutes and accurately meters out the quantity of ballast to be dropped in response to this fall in altitude. We chose this particular time interval because hydrogen-filled, zero pressure balloons have a natural vertical oscillation period of about 4·7 minutes. During three such oscillations—14·1 minutes—the system makes 16 altitude measurements. The average of these reveals changes in the mean altitude which are smaller than the amplitude of the natural oscillations. It is possible to change the response characteristics of this control system during a flight by means of the telecommand link. Experience shows that careful management of the rate of release of ballast during, and before sunset, can achieve good stability in altitude, releasing typically 8 per cent of the gross weight of the balloon system at a time.

As well as maintaining the ideal altitude, we needed to determine the position of the balloon continuously with a precision better than $\pm\frac{1}{4}°$ in both latitude and longitude. To meet this requirement, we developed a balloon location system based on the use of signals from the Omega radio navigation transmitters. Omega is a long-range navigation system in which bursts of radio signals, very accurately related in time, are transmitted from eight stations located in such a way as to provide world coverage. The balloon-borne instrument measures the phase difference between selected pairs of these signals. The integral of this phase difference from the launch point is measured and transmitted to the ground station. Two such phase measurements, when plotted on specially prepared maps, give an accurate position for the balloon.

With financial support from the SRC and design work on these problems proceeding, we had to choose a launch site for the test flights of the balloon. We settled on a site in the north-western tip of Sicily, a little north of 35°N, where the climbing balloon would be no hazard to aircraft in major air lanes, and with Spain conveniently placed to the west so that if necessary we could abort the flight after 12 to 20 hours if the automatic systems showed any signs of malfunction. The Italian Research Council provided enthusiastic support for the project and handled negotiations with the Spanish authorities; the site chosen, near Trapani, now seems likely to become a major centre for launching scientific balloons.

The actual launch operation and the arrangements for recovery of the balloon and the scientific payload in the United States were handled for us by the National Scien-

Preparations prior to a balloon launch take place during the day, but the actual launch often takes place during the night

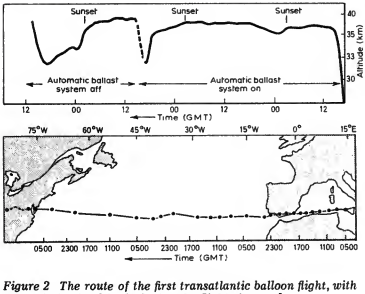


Figure 2 The route of the first transatlantic balloon flight, with the variation in altitude during the flight shown above

tific Balloon Facility. So far, we have made three attempts to fly scientific payloads across the Atlantic. In 1975 the first flight was launched on 29 July and reached Lexington, Kentucky after 76 hours at float altitude (Figure 2). This demonstrated the success of the balloon location system. The positions agreed very closely with those supplied to us by the Spanish Air Traffic Control radar and also by the NASA radar facility located on the island of Bermuda. A tracking aircraft met the balloon after crossing the US coastline and followed the balloon to its safe recovery in Kentucky. The altitude control system also functioned very well (Figure 2), although the flight did show a need for some improvements, which we made before the 1976 flights. A good stable altitude was maintained at sunset on two nights with the expenditure of only 7 per cent of the ballast, but the serious effects of passage over cold banks of clouds at night also showed up on this flight.

Two flights were made in 1976. The first of these balloons was last seen about 1000 km due east of New York City. When radio contact was lost it was at a good stable altitude and there were adequate reserves of ballast for it to survive the presence of cold clouds for another sunset. We suspect that the balloon burst or that the automatic cut-off triggered prematurely, landing the balloon in the sea. The second flight of 1976 reached Worcester, Massachusetts after a flight lasting 103 hours.

So far, the results of these experimental flights are mixed. The good news is that the technique works, keeping balloons aloft and trackable for several days; the bad news is, that without giving over a disproportionate amount of payload to ballast, altitude control cannot be maintained well enough over the width of the Atlantic. But an intermediate technique, flying over land at the times of year when winds are light, could keep similar balloons aloft for 4 to 5 days. The value of such flights could be improved using a second balloon, launched when the first is passing out of the line of sight, to act as a relay for signals from the scientific payload to the ground station, extending communication range (and lifetime) by a factor of 2 for an increase in cost of about 10 per cent.

For the future, it might prove possible to extend the stable range of the balloons by carrying a store of extra helium in liquid form, providing extra lift instead of dropping ballast to reduce weight. With a 2000 litre vacuum flask (dewar) replacing a comparable weight of ballast, we believe that transatlantic flights from Sicily to the US could be kept accurately at the required altitude for seven sunsets—but this cryogenic ballast system depends on developing a microprocessor control system which can vent precise quantities of helium into the balloon as required. Such a system may fly in 1980; by 1981, we hope to see regular 10-day flights, perhaps using a high quality satellite link to relay 10 000 bits of data per second back to the ground station—a real competitor to the scientific payloads planned for the Shuttle. □

What makes a plane crash

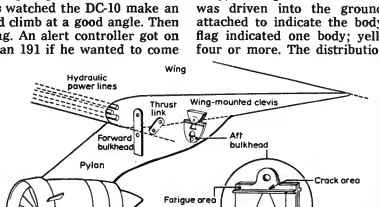
The recent DC-10 crash drew attention to the detective work that follows in the aftermath of an air disaster. Despite the inherent difficulties less than 3 per cent of plane crashes remain unsolved

Lee Torrey
is a freelance writer based in Massachusetts

It was just after 3 pm on 25 May, 1979, when American Airlines Flight 191 taxied to the threshold of runway 32R at O'Hare International Airport, Chicago. After giving the crew final clearance, the air traffic controllers watched the DC-10 make an apparently normal take-off and climb at a good angle. Then the engine fell off the left wing. An alert controller got on the blower and asked American 191 if he wanted to come back for an emergency landing. But there was no reply from the DC-10, which yawed violently to the west, dropped behind the hangars, and burst into a 45 metre fireball.

Within the hour, the US National Transportation Safety Board (NTSB) in Washington DC began to mobilise an investigation. By sunset, 14 technical detectives led by Edward Dreifus, veteran of the 1974 Turkish DC-10 crash inquiry in France, were heading for Chicago.

When the investigators arrived at the crash site, firemen were still hosing hot spots, while rescue workers carried yellow body-bags through the steam. Where they found a body, or a significant collection of body fragments, a stake was driven into the ground and a coloured flag was attached to indicate the body count for that area. A red flag indicated one body; yellow for two or three; black, four or more. The distribution as well as the condition of the victims provides important clues about how a plane crashed. Twisted backs can confirm a tail-spin, characteristic hand fractures often establish who was holding the controls at the time of the accident. At the Chicago crash not a single body was found intact, suggesting that the plane struck the ground at nearly 320 km/h.



Details of the DC 10-engine mount assembly

It was also apparent from the distribution of the wreckage that the pilot had little, if any, control over the

Photographs AP

Firemen mark the positions of bits of bodies among the wreckage while, below, one of the engines is loaded onto a truck

plane's steep descent. Unlike the 1974 Turkish DC-10 crash near Ermenonville, where the crew managed to bring their jumbo in on a shallow angle of impact, spewing debris over 770 metres, this DC-10 had dropped abruptly. Its wreckage was contained in a single gouge of earth barely 185 metres long.

By 7.30 on Saturday morning more than 100 investigators had arrived from three federal agencies, as well as from American Airlines, McDonnell Douglas, and the Air Line Pilots Association. NTSB vice president Elwood Driver set up a command post at the Sheraton-O'Hare Motor Hotel and organised the work force into eight specialised parties. The structure team was responsible for pin-pointing the cause of the inflight engine separation; the systems team was to investigate whether electrical or hydraulic failures led to the pilot's loss of control; the power plant group was to determine whether the DC-10's remaining two engines had provided full power before the crash. Other working parties handled witness interviews, maintenance record reviews, flight operations, weather and human factors.

The prime suspect from the beginning of the inquiry was the No. 1 GE fan-jet engine and supporting pylon which, after tearing away from the left wing, had landed to the right of runway 32's centreline, skidding to a halt near the 8000 foot marker. The structures team spent much of Saturday gathering the scattered pieces from the 555 metres zone of debris, in order to reassemble the engine pylon for clues as to what components failed.

Full 3-D mock-ups of crashed planes have been built by the NTSB, especially when tracing the origin of inflight explosions. To solve a 1960 DC-6B crash in North Carolina, investigators put over 15 000 pieces of fuselage together on a frame made of chicken wire and wood strapping. Construction of this mock-up soon revealed a gaping hole in the passenger cabin. However, it was not until several weeks later, when the body of one man was found 32 km from the main wreckage with a piece of an alarm clock embedded in his leg, that investigators established the exact location of the time bomb—under his seat.

Sifting through the main wreckage in Chicago, two NTSB workers found the plane's black boxes—actually painted orange—early on Saturday morning. The digital flight data recorder, which had plotted the position of 41 flight control indicators over the last 25 hours of flight, was taken to NTSB headquarters to obtain a full read-out. Investigators are keen to examine events in flight prior to the plane's last takeoff, to see if any unusual *g*-forces could have contributed to the engine separation.

Playback of the cockpit voice recorder produced some new information about the accident sequence. The record-

Jim King, chairman of the NTSB, opens one of the black boxes (above). Details from this flight recorder will be fed to the simulator (left) to reconstruct the fatal flight

McDonnell Douglas Corp

ing of the pre-flight checklist and control tower clearances indicated that nothing seemed wrong with the jumbo before it raced down runway 32R. When American 191 came close to its commitment velocity of 152 knots, one of the flight crew announced V_1. Moments later he said, V_r (rotation velocity), then an unidentified thud can be heard, followed closely by an exclamation, "Damn." The cockpit voice recording, powered by the No 1 engine, ends abruptly at this point as the engine tore up and over the wing.

The No 1 engine also powered the No 1 hydraulic system. This might explain why the crew lost control of the plane, which its builders, McDonnell Douglas, claim can take-off with only two engines. Careful examination of the few remaining pieces of the left wing—to assess possible damage to the No 2 and No 3 hydraulic lines—has turned up little useful information. From the severed hydraulic lines found with the engine debris near the runway, the NTSB tentatively proposed that the leading edge slats on the left wing, without hydraulic pressure to keep them extended in the high-lift take-off mode, must have retracted into their faired position. If the right-wing slats remained deployed while the left-wing slats retracted, the resulting asymmetrical lift would have caused the jet to yaw and roll to the left, which agrees with eye witness accounts of the crash. Both McDonnell Douglas and American Airlines object to this scenario, claiming that the DC-10's hydraulic system interlocks would have prevented the leading edge slats from operating asymmetrically.

The mystery may be solved when the plane's flight data recorder read-out is made available to the McDonnell Douglas computer-driven motion-base aircraft simulator. This facility, located at Long Beach, California, will attempt to duplicate the DC-10's 45 second flight, taking off with only No 2 and No 3 engines, and repeating the simulation with increasing loss of hydraulic power.

The hydraulic system on the DC-10 has been a sensitive issue since the "crowning achievement of the McDonnell Douglas line" went into service in 1971. Before the Turkish crash at Ermenonville, there were 89 reported incidents involving hydraulic control, a few of which involved the loss of two of the plane's three hydraulic systems while in flight. Critics are quick to note that the Boeing 747 and the Lockheed Tri-Star—widebody jets developed at the same time as the DC-10—have installed four hydraulic systems, each independently capable of providing enough control to land the plane in an emergency.

Following the 1974 Turkish crash, the US Federal Aviation Administration (FAA) ordered McDonnell Douglas to make modifications to the jumbo's hydraulics. In the Turkish disaster, as in the DC-10 accident over Windsor, Ontario two years before, a cargo door blew off, causing explosive decompression, which collapsed part of the cabin floor, cutting hydraulic lines running the length of the plane's underbelly.

At 2.30 on Sunday afternoon, nearly 48 hours after the crash, the structures team, after sweeping the runway area with metal detectors, located a missing thrust link assembly, including a belt, a bushing, and a broken 3-inch bolt with the nut still attached. But as NTSB's Elwood Driver displayed the broken thrust link bolt to reporters as the possible cause of the engine separation, McDonnell Douglas engineers were expressing doubt that the bolt failure alone could have precipitated the crash. The thrust link bolt does not support any load, and is designed to hold a bushing in place at the attach points at both ends of the thrust link. This link absorbs the bulk of the 40 000 pounds (18 182 kg) of engine thrust, while the pylon attachments carry the engine's 5000 lb (2273 kg) vertical load.

Word began to spread, however, that fatigue had caused the bolt to snap, even though the specimen had not yet arrived at the NTSB metallurgical lab for examination. One investigator called it the "murderous bolt", and another likened the developing DC-10 inquiry to that following the crash of a TWA Lockheed Constellation which fell on Chicago suburbs shortly after take-off in 1961. The Civil Aeronautics Board, crash investigators at that time, after poring over the rubble, concluded that the accident occurred when a 5/16 in nickel-steel bolt in the elevator boost mechanism vibrated loose, leaving the pilot with no way to control the plane's dive.

While the structures and systems teams were making headlines, the other working parties were providing Dreifus with critical background information. Over 150 witnesses were interviewed, including some cranks. Photographs of the take-off and crash were obtained from tourists and one student pilot (he also sold it to the *Chicago Tribune* for $5000). The aircraft that crashed was the twenty-second off the McDonnell Douglas assembly line and was delivered to American Airlines in February 1972. It had logged 19 870 flight hours prior to the 25 May crash. The plane's last heavy maintenance inspection was conducted at the American facility in Tulsa, Oklahoma last March. Inspections conducted at that time indicated there were no cracks in the thrust link assembly—casting more doubt on the theory that this assembly caused the accident.

The remains of the victims were taken to an American Airlines hangar at O'Hare, where Dr Robert Stein, Cook County Medical Examiner, headed a forensic medical team, including 37 FBI identification experts and 16 Chicago homicide detectives. Dr Stein commented that he had never seen so much burned flesh and bone, and predicted that it might not be possible to identify all the victims. He may well be right. Following the 1978 San Diego mid-air collision of a Pacific Southwest Airline's Boeing 727 and a light plane, it took five weeks to examine 140 victims. One was identified by a single finger print, another by a credit card fragment.

Teeth identify the victims

In Chicago, Dr Stein is relying heavily on forensic, dentistry-based techniques of identification. Using 99 possible characteristics, examiners compare X-rays and dental charts before and after death, and even when the teeth are shattered, the jaw structure, root position and root canal work can provide supporting evidence. Of the 140 positively identified victims of the San Diego disaster, 50 were established with X-rays alone.

By Monday, 28 May, the DC-10's three engines were on their way to the American heavy maintenance facility in Tulsa for detailed examination. The flight data recorder readout for the last minute of the plane's life revealed that the remaining two engines were providing power until the end. But the airspeed indicator—recovered from the wreckage—showed the DC-10 was approaching stall speed around 137 knots, at the time it crashed.

The power plant team found itself caught in a dispute between the manufacturers and the FAA over whether the DC-10 could fly with only two engines. In Washington, FAA chief Langhorne Bond called a press conference and announced flatly: "There is no procedure of any sort to provide for it to fly without an engine . . . There is no reason to think that once an engine comes off the plane will fly." But many engineers expressed doubt as the DC-10 obviously did obtain take-off velocity without the No 1 engine and climbed to an altitude of 185 metres before falling to the ground.

Late on Monday afternoon, the structures team found the aft pylon bulkhead, which connects the pylon to the wing. Initial inspection by the NTSB turned up witness marks and other abnormal markings where the bulkhead had been torn from the wing-mounted clevis bolt. The bulkhead, clevis bolt and other components were flown to the metallurgical lab, and the FAA ordered a one-time inspection of all DC-10 pylon attach points.

The McDonnell Douglas service bulletin covering the inspection recommends the use of fluorescent penetrant dyes. An oil-based liquid dye is applied to the surface to be inspected, left to sit for 30 minutes, and then wiped clean. A white powder is then sprayed on the specimen, which draws the dye out of the cracks. Using an ultraviolet lamp, small cracks and pockets of corrosion as tiny as 0·00025 cm can be detected.

NTSB chief metallurgist John Marx examined the thrust link bolt under an electron scanning microscope obtaining magnifications up to 100 000×. By Tuesday he had concluded that a sudden overload condition had snapped the bolt and not metal fatigue as had been originally suggested. After similar, non-destructive metallurgical analysis of the aft bulkhead, he found a combination of transcrystalline and intercrystalline fractures and concluded that the aft bulkhead flange had collapsed first because of metal fatigue and perhaps because of other factors, too. He also said that the thrust link bolts had broken next, followed by the forward mounts which broke suddenly as the engine's thrust lifted it over the top of the left wing.

Within hours of the FAA ordered inspection, reports of faults reached the NTSB. A crack had been discovered on a web attachment flange in the aft pylon bulkhead of a Continental DC-10 in Los Angeles. Then 5-cm cracks were found in two American Airlines DC-10s in San Francisco. And, most suspicious, mechanics said these cracks had developed in both planes since their last inspection only 100 flight hours earlier. By Friday night, a week after the accident at O'Hare, it became known that over half the US DC-10-10 fleet had pylon problems of varying magnitude. (The DC-10-30 and DC-10-40 series, operated by many European airlines, have a strengthened pylon structure and have not reported fractures.)

One NTSB official remarked at this point that it was beginning to look like the probe of the ill-fated Lockheed Electra. Introduced in 1959, the Electra was the first commercial turboprop plane in service, and the fastest, boasting an airspeed over 400 knots. Over their first three years in the air, six Electras were involved in disastrous accidents. After the first two crashes it was established that the wings were snapping off the fuselage in flight, but the wreckage itself gave no hint of the reason.

Under the supervision of the CAB, Lockheed conducted thousands of hours of tests over a nine month period, subjecting the Electra's wings to varying conditions of vibration and stress. Wind tunnel work finally revealed that the problem was not in the structure of the wings, but in the engine mounts. The simulated high wind speeds loosened the engine mounts and set the engine wobbling; the vibration would spread to the wing which would flutter violently, and within 30 seconds the wing would rip right off the plane. All Electras in service were recalled to Lockheed's California factory where the engine mounts were strengthened at a total cost of $25 million.

An NTSB observer at the American Airlines maintenance base in Tulsa produced the first clue that the DC-10 pylon problem might be more than structural. While watching the American mechanics lower, inspect, and replace the engine and pylon as one unit, he noticed that the fork-lift operator had limited control, especially of the aft bulkhead fitting which would strike the wing-mounted clevis during reinstallation. The NTSB checked out this maintenance procedure and found that it was approved by the FAA, but contrary to the recommendations of the manufacturer.

The NTSB released a recommendation that the airlines discontinue this "questionable maintenance practice" at once. The safety board recommendation to the FAA noted that "vertical misalignment of a fraction of an inch can result in the pylon aft bulkhead upper horizontal flange assembly striking the forward ear of the wing-mounted clevis, causing the flange to crack." The NTSB also said the aft bulkhead cracks were being discovered in the same area in most of the faulty DC-10's and speculated that this practice may have caused the 10 in (25·4 cm) pre-impact fracture found on the aft bulkhead of American 191.

American Airlines, for their part, say they have been removing and replacing engines and pylons together since April 1977 and that McDonnell Douglas personnel have observed this process and found nothing wrong with it. The NTSB is now designing three tests to determine whether the aft bulkhead cracks do in fact arise as a result of this fork-lift operation.

Finally, on Wednesday, 6 June, the FAA withdrew the DC-10s airworthiness certificate, an unprecedented action in the history of modern aviation. But the NTSB investigation is not over. At the McDonnell Douglas headquarters in Long Beach, California, the investigators are looking into the original process of granting the DC-10 its certification by the FAA in 1971, examining records of the design as well as the criteria used by the FAA in accepting the design and approving the structural integrity of the pylon. NTSB will announce a public hearing later this summer at which it will present its findings. □

The big inquiry

How can society make decisions about technologies that will dominate our lives for many years?

Brian Wynne
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How should the government organise public inquiries into the big technological decisions whose outcome could dominate our lives for many years to come? The Windscale Inquiry was the first real attempt—albeit *ad hoc*—to answer this question. Although an advance on the conventional planning inquiry, Mr Justice Parker's investigation was far from perfect. Soon, the government will have to decide how—or even whether—to organise an inquiry into the first commercial fast breeder reactor.

Thus the report *The Big Public Inquiry* from the Council for Science and Society and the Outer Circle Policy Unit, published two weeks ago, is timely indeed. The working party that wrote the report consisted of Windscale veterans, experienced lawyers, academics, and others with practical and analytical experience of the politics of technology and planning. As a member of the working party, I believe its report makes several sensible advances on the Windscale model. But the working party deliberately restricted its field of vision and left key ambiguities in its proposals.

One of the strengths of *The Big Public Inquiry* is the accumulated force of several proposals pushing in the direction of natural justice—a fair fight—in such inquiries. It proposes much stronger rights, at least for a certain class of objectors, in return for greater mutual organisation and discipline. Even if the government accepted these proposals, they would be only a small step down the road to natural justice, but they could change the whole climate of decisions about big technology. Some of the proposals echo others' recommendations: more time and powers for extracting (and analysing) strategic information; resources for objectors' research; and, crucially, a clear acknowledgement of the social perspectives that often underly different technical standpoints in the energy debate. *The Big Public Inquiry* endorses what is now almost a standard recipe for the breeder inquiry—an extensive general inquiry into the policy context of the project (for example, futures, civil liberties and economics) under a commission, followed by a parliamentary debate on the commission's report, a vote, and (if the vote is favourable) a normal local planning inquiry, or several simultaneous ones at designated sites. The commission would not make any overall recommendations, but would spell out options, consequences, and uncertainties for parliament and the cabinet. In this way, the local public inquiry, having been preceded by a thorough "project inquiry" would not suffer the damaging controversy and confusion that have beset many recent local inquiries because objectors felt justified in questioning (often disruptively) the obscure way in which government had (or had not) decided the policy context of the local development. John Tyme's continual battles at motorway inquiries are perhaps the clearest examples of this disruptive questioning of policy context.

Probably the most original idea in the report is an attempt to tackle the problem that participation in a public inquiry is far too late to be effective. At a late stage objectors have to attempt to unscramble and reverse what are usually hard and fast political, economic and emotional commitments on the part of developers. Inevitably, objectors then appear as Luddites fighting a lost cause. Thus the CSS/OCPU report suggests that the "project inquiry" begin not after a specific planning application but that it should be triggered by a new requirement on developers to give notice of planning applications two years before the applications go forward. A developer which did not give notice could be delayed for two years while the project inquiry went ahead.

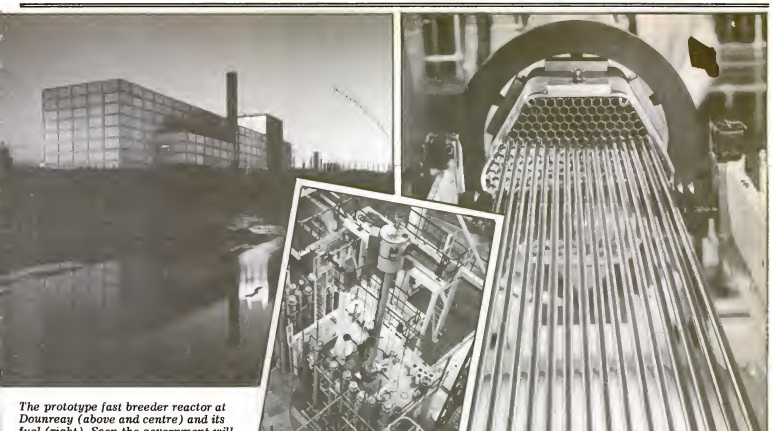
But there are problems with the project inquiry idea. No government would set up such an elaborate and expensive process in the abstract—there has to be something concrete at stake. And there is no single ripe time to make a decision about complex technology. Conceivably a project inquiry for the fast breeder reactor could have decided in favour in 1974 only for us to regret that inquiry as a disastrous waste of money, say in 1980. Just as there was great pressure on Mr Justice Parker not to issue a supposedly watery "not yet" verdict on Windscale, so there would be even more pressure on a commission holding a project inquiry to arrive at a clear-cut decision. A commission would risk being lampooned for wasting public money on a "non-decision", and the industry would inevitably demand to see its future laid out in black or white—even if, on the evidence, procrastination would be the best policy.

In theory, the two-year notice period proposed by the CSS/OCPU report would accommodate the project inquiry and so cancel out any delay. But in practice a rigorous project inquiry could last longer than two years. Against the timescale of potential consequences, even an inquiry lasting five years would not be unjustified. To its credit, the CSS/OCPU working party did not flinch from this observation. But an even greater problem is that things change: a good decision one year may a bad one 10 years later, after billions of pounds have been wasted, or serious energy shortages invited. A decision as important as that on the fast breeder reactor will *make* the future because it will foreclose some options and open up others. The bigger and more pervasive the technology, the more these options include broad social effects, and the more irrevocable they are. The bigger the technological commitment in a decision, the more we apparently gain control.

Too big to handle

But this control may be illusory because the bigger the decision to be made, the more ignorant we are of its implications and of the social and other changes we set in train. It may be that grandstand decisions on big technologies like the fast breeder reactor are intrinsically too big for our democracy to handle—a point against the development for that reason alone. This logic redefines the problem in terms of the political economy of technology—its scale, centralism, inflexibility, and so on—and not in the relatively superficial terms of formal procedure. Our society may well have been better equipped to face the awesome decision to enter into (or refuse) the "commercial" stage of fast reactors, if it were used to routine openness and debate about the safety, economics and technology of the fast reactor instead of occasional ritual ordeals.

One of the key ambiguities in the CSS/OCPU report concerns the role of the commission that would conduct the project inquiry. Although, in theory, the project inquiry would be a public process, it could easily be dominated by a series of separate written exchanges between the commission and different parties. After an initial hearing to define the issues, requests for documents, information and research funds would be in writing. Only the commission would have its finger on the pulse of the inquiry. Further, it would have immense power to rule whether documents should be released, whether an apparently dead issue should be pursued, resources given to a party, when to call a halt to proliferating argument, and so on. Such powers



UKAEA

The prototype fast breeder reactor at Dounreay (above and centre) and its fuel (right). Soon the government will have to decide how to organise the public inquiry into the commercial breeder

place extraordinary importance on the membership of the commission, which, the report recommends, should be appointed by the Minister after consultation with objectors —among others. Even with a durable, patient, and broad-minded commission, project inquiries could become so private as to be virtually invisible to the outside world beyond the elite of professional objectors, and incoherent and fragmented even to them.

After much internal debate, the CSS/OCPU was undecided about how much cross-examination should take place at a project inquiry. Some members felt that written commission proceedings would focus attention on a few questions where credibility was at stake. In particular they felt that a project inquiry should not subject technical experts to the supposed indignity of cross-examination. If the report's advice were accepted, adversary hearings would therefore be very limited.

But credibility is always at stake in judgements between different schools of thought, social or scientific. Bare evidence alone decides nothing. Furthermore, written exchanges would be woefully inefficient, because it is so easy to misread a request and provide the wrong or partial replies. It is only possible to pose alternatives clearly and starkly through cross-examination. Adversary proceedings, including the cross-examination of government witnesses, should be a major part of the project inquiry, a point whose rather furtive acceptance at Windscale does not yet render the principle secure. Cross-examination not only resolves factual questions but also (and more importantly) exposes the social premises and uncertainties underlying different technical points of view. Perhaps the view that the scientist's constitution is too delicate for the public rough house of adversary proceedings was a reflection of the presence of eminent scientists from the CSS on the working party. Yet adversary proceedings expose valuable truths, at times, even if the truth is that no one knows. Further, public legitimation requires a public ordeal for the experts, whatever they think they might achieve in semi-sheltered correspondence with the project inquiry commission.

The debate on the CSS/OCPU working party on cross-examination signals a basic failing in its report. A project inquiry with limited public hearings and debate would be almost inscrutable to outsiders. Yet the report makes no mention of the need to stimulate the interest and intelligence of a wider public and to assess its views. Not that the man or woman on the proverbial Clapham omnibus would have very much to say about the fast breeder reactor. But the fact that he or she has nothing to say may be the most important limitation to the practicability of inquiries like that on the fast breeder reactor (which the new government may not hold after all).

It would be ironic if the report's recommendations on the shape of the fast breeder inquiry helped the hard core of professional objectors (who need little help)—only to make participation all the more daunting for interested but less experienced, less organised groups or individuals. Representation becomes less and less meaningful the more inquiries are highly elite, professionalised, and semi-private exchanges between strongly committed adversary parties. More elaborate inquiries may buy more natural justice for professional objectors only at the expense of even more alienation of the wider public. Such procedures only widen the cultural gap between decision-making elites (including objectors) and the public.

The CSS/OCPU report is a constructive contribution to the debate about big technology inquiries. But it fails to understand the deeper currents in the economic and political structure of technology which so influence the consequences—intended and unintended—of whatever formal procedures we evolve. Such currents may well be the undermining harvest of too much adaptation of "democratic" procedures to the exigencies of "the technological society". Perhaps the adaptation should be in the reverse sense. Otherwise we might be like the man walking up a landslip—if he keeps his eyes on his feet, he can pretend he is making progress. □

New life for lame horses

Rat poison is the basis of a new treatment that will save the lives of countless working horses

Mary Evans

Robert Pilsworth is a freelance writer specialising in veterinary matters

Navicular disease is a major cause of severe lameness in horses. Horses afflicted with the disease were often simply shot, but July will see the publication in the veterinary press of details of a new treatment that allows the previously incurable navicular disease to be conquered. Surprisingly, the agent responsible for this dramatic therapeutic breakthrough is Warfarin, the well known rat poison.

The man who developed this new and radical approach to navicular disease, which strikes particularly at hard-working horses such as hunters, eventers and show jumpers, is Chris Colles of the Equine Research Station in Newmarket. I recently visited him to ask about the development of this therapy, and its current success.

The navicular, or coffin, bone, is one of the smallest bones in the horse, and sits tucked in between the second and third phalanges (finger, or toe, bones) of the foot (see Figure, right). It is one of a group of bones known as sesamoids, similar to our knee-cap (or patella). These small bones develop within tendons that run over joints, at points where the tendon would be most prone to wear. For example, we have sesamoid bones in the joints of our fingers, behind and in front of our knee, and in our feet. Behind the navicular bone runs the deep digital flexor tendon, a thick strap of connective tissue which, among other things, keeps the hoof surface flat on the ground as the horse's foot bangs down during a gallop. The navicular bone then, though tiny, is by no means insignificant. It is subjected to constant wear and compression as the enormous weight of the horse in full gallop slams onto the turf.

It's not surprising then that one small fault in the bone could be suspected of causing lameness; but why should the tiny navicular bone last some horses all their lives and yet break down in others? This question has remained unanswered for over two hundred years, ever since a Mr Jeremiah Bridges first reported pathological changes to the bone in 1752.

Earlier studies on navicular disease made great play of small erosions and discoloured patches on the flexor surface (the surface of the bone next to the tendon) and this was the prime suspect as a cause for the lameness. Modern textbooks on lameness in the horse hold on to this idea, supposing the condition to arise as a result of some predisposing weakness in the navicular bone, which then collapses and leads to a bursitis (a miniature "housemaids knee"); ultimately the large tendon "strap" which runs behind the bone becomes inflamed. Some people, though, had drawn attention to irregularities in the blood supply to the bone which were sometimes seen in confirmed cases of navicular disease. The problem was to separate changes that *cause* navicular from other, secondary changes *caused by* the disease. Realising that the blood vessels were involved in the *causal* pathology turned out to be very important in attempting the new treatment.

Establishing the cause

Chris Colles first became interested in navicular disease when he was working as a vet in practice. "I just got fed up with shooting them all" he told me. When he came to Newmarket four years ago, he set out to find out more about the condition. His first move was to contact one of the country's leading equine orthopaedic surgeons, Lt Col. John Hickman, who worked nearby at the Cambridge University School of Veterinary Medicine. "He's had a lot to do with getting me off in the right direction. The first thing we did was to look at the *normal* blood supply to the navicular bone. In trying to establish that, I started to see some abnormalities in the blood supply in navicular disease. At the same time I started X-raying and examining normal horses' feet at post-mortem, to get an idea of the range of normal navicular anatomy. It soon became

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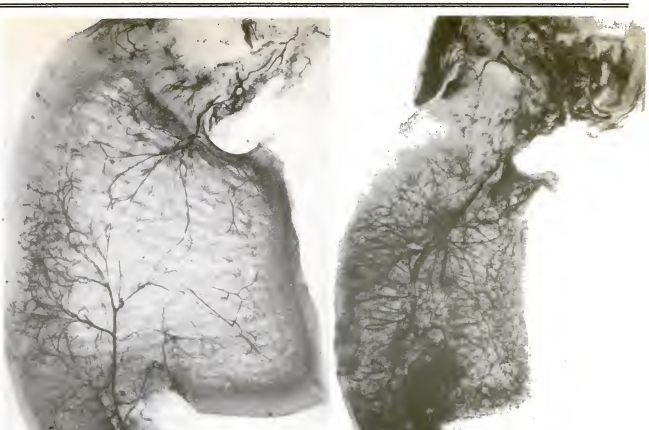
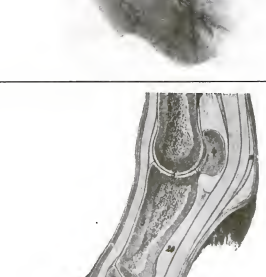


Blood supply to the navicular bone revealed by injecting the arteries with Indian ink. The normal bone (right) has a clear supply, while in navicular disease (far right) blood supply is complicated by a profusion of new vessels to overcome the blockage to the nutrient foramen, the large blob at the bottom of the bone

Chris Coles



—Sagittal Section of Distal Part of Limb of Horse.

1, Large metacarpal bone; *3*, fetlock joint; *4*, proximal sesamoid bone; *5*, first phalanx; *6*, pastern joint; *7*, second phalanx; *8*, coffin joint; *9*, third phalanx; *10*, distal sesamoid (navicular bone); *12*, suspensory ligament; *14*, deep flexor tendon; *15*, superficial flexor tendon; *16*, posterior annular ligament of fetlock; *20*, inferior sesamoidean ligaments; *21*, extensor tendon; *24*, plantar cushion; *25*, periople; *28*, wall of hoof; *29*, sole of hoof; *A*, navicular bursa, proximal part. (After Ellenberger-Baum, Anat. für Künstler.)

fairly obvious that the so called pathology of navicular disease occurred in normal horses, and not infrequently did not occur in cases of navicular disease." It looked then as if the accepted view of just what was going wrong in navicular disease was mistaken. The erosions and discolorations noted in many of the previous studies were just as common in normal sound horses as in those with navicular disease. What was not common in sound horses but present in *all* the cases of navicular disease was a thrombosis, or clotting, in the main nutrient arteries that enter the bone at its bottom edge (see above). So, could blockage of the nutrient artery cause lameness? Certainly stopping the blood flow to any part of the body results in an intense pain, known as ischaemic pain. Bone is no exception and pain itself is the root cause of most lameness. This then set Colles's inquiry onto the track which eventually resulted in the new cure, looking not at changes in the bone as the prime cause, but at changes in the blood supply to it. As Colles put it, "The important turning point was deciding that the accepted pathology was not correct".

Colles launched a large survey of over 125 horses, 30 of which were diagnosed "navicular" horses. Looking at the navicular bones on X-ray he found that the shape and number of the tiny blood vessel inlet holes at the bottom of the bone, the so-called nutrient foramina, could be used to diagnose navicular disease. In the normal horse, they were cone-shaped, and relatively few in number. In navicular disease, the cones mushroom out into large globular shapes, and often increase in number. This is the tell-tale sign of attempts by the bone to *increase* its blood supply. But why should it need to do this? The answer seems to be that the main blood supply to the bone has begun to fail as a result of blood clots in some of the main blood supply trunk-routes to the bone. Once again it began to look as if the condition was one of ischaemic pain, caused by lack of blood flow to the tissues within the bone, rather

than specific damage to the bone. Death of areas of the bone *could* then occur in later stages, but would be the result, not the cause, of the condition.

In the face of most of the established views on the disease, Colles pressed on, convinced that he was right and that, given a chance, this attempt by the blood supply to restore normal circulation in the bone could succeed, and the lameness might then disappear. The problem, however, is that the thrombosis itself doesn't stop at the main arteries but for some reason spreads to block the new auxiliary circulation as soon as it starts to supply blood. More blood vessels spring up in reponse, but they too block up. It seemed that what was needed was to give the horse some help in getting this new secondary circulation going and keep it free from clots; that help was to come from Warfarin.

A chance conversation

Like most novel ideas, this one was thrown up in a chance conversation with a colleague. "I was sitting in the back of a meeting talking to Jim Patterson, a vet from Newark. We were getting bored and chatting about other things when he asked me if I'd thought about using Warfarin with my horses. I said I hadn't, so I came home and tried it." It worked.

In fact, as Colles was well-aware, experimental studies on other totally unrelated conditions supported the use of Warfarin as an anti-coagulant. The familiar rat poison, and similar chemicals, are used to "thin" the blood of people with a tendency to thrombosis. He treated his first horse over 18 months ago and its lameness vanished in a few weeks. It has been sound ever since. Without the treatment it would have now been destroyed. The treatment itself is a carefully measured dose of Warfarin in the food daily. Getting the dose right is critical. Various measures exist to say just how quickly blood reaches each stage in the clotting process. Colles concentrates on the so-called one-stage prothrombin time, which is normally around 10-16 seconds. He gives just enough Warfarin to increase the one-stage prothrombin time by two seconds. All horses vary in the amount of Warfarin they require, and at first great care has to be taken to get this just right. The 15 per cent prolongation of clotting time is conservative when compared with human therapy for thrombosis, in which clotting time would be doubled; but, "with a human, you don't then put a horse on his back and jump him over fences". This highlights the need in the horse to reduce the clotting ability of the blood only marginally so that its normal role in preventing internal bleeding (the very function which Warfarin is *designed* to hit as a rat bait, making the rat bleed to death from minor internal injuries that would normally be overcome by the blood clotting) is not affected. The two-second delay seems to be just enough to prevent thrombosis of the newly invading blood vessels in the bone, without unwanted side effects.

Gradually, more and more horses were referred by practicing vets to Mr Colles for treatment. The work, however, is hampered by lack of money, staff and facilities. Like almost all research departments, the Equine Research Station is short of funds, but unlike most other research units the station gets no financial support from the government. It is funded completely by the Animal Health Trust, a charity which depends exclusively for its support on voluntary contributions. With an annual running cost of almost £600 000 and several other important research projects underway, the navicular study can expand only slowly.

Forty-three horses have been treated so far. All of them, with the exception of two or three very advanced cases beyond help, have gone sound and stayed sound ever since. Naturally Colles is delighted with the progress. Six other practices have now adopted his therapy in the UK, and another seven or eight scattered throughout Europe and America. What has been disappointing though, is its slow acceptance by the universities. Colles is prepared to accept that people may not believe his theories, "especially when what I'm saying is completely contrary to what everyone else has been saying for a very long time". There is still huge disagreement in the profession over the initial cause of the problem, let alone any attempts at curing it. He feels, however, that they should at least give his method of treatment a try. Most of the horses he eventually sees have seen several specialist vets already, and have made no progress. The owners are ready to try anything. "They wouldn't come here if they weren't desperate," he observed, and the alternative to his treatment would almost certainly have to be humane destruction. The vet schools get the same sort of horse referred to them, but still send them away as incurable; there could be nothing to lose by attempting the Warfarin treatment. Only the day before our interview, a horse was brought in which had been prescribed the treatment known in the horse veterinary world as "high velocity intra-cranial lead". Obviously a suitable case for treatment: Colles took on the horse and expects it to go sound in the near future, all being well but, as he said, "that sort of advice is not very helpful".

There *are* ways of dealing with navicular disease, all of which have their exponents. One is to cut the nerves which convey the pain from the bone. But this doesn't stop the conditions getting worse; the horse just doesn't feel it any more. The operation is not difficult but can have severe side effects, including complete sloughing-off of the hoof: the whole hoof drops off! Most of these stop-gap treatments are unsatisfactory, and often give only temporary relief. This is well illustrated by a German survey of 580 cases of navicular disease, which sought to compare the effectiveness of the then-available treatments. Only 60 horses were still alive a year later to evaluate, and of these, less than half had shown any improvement. But the overriding evidence of the desperate need for the new therapy is the number of vets who ring up the Equine Research Station every day.

The significance of the new work isn't limited to horses alone though. Navicular disease mimics closely certain conditions in man, such as "bone necrosis" (a rag-bag term that covers many varieties of bone death) for which there is also no suitable treatment. Caisson disease, which affects people who work under high pressure and are suddenly decompressed, may also have some points in common with the equine condition. Colles also points out that the use of Warfarin on the horse allows us to *see* its effect, in terms of lameness, in a way which is impossible in treating human thrombosis. If the amount of Warfarin in the blood drops even a little the horses once more go lame. So, knowledge gained from the navicular study could have something to offer human medicine. Colles is already working with Dr Murray Brooks at Guy's Hospital, London, where they are looking at blood supply to the bone, and this collaboration between veterinary and human medicine is expected to prove of great value to both sides.

Chris Colles himself plans to go on treating horses at the station but he also has other research lines he would like to pursue, funds permitting. The study has thrown up several problems of differential diagnosis in the foot (how to tell one condition from another) which he would like to look at in depth. Of course we still don't yet know what causes the initial thrombosis of the main arteries to the bone, the root of all the trouble in the first place. There certainly seems to be a genetic component in there somewhere as the condition is much more common in the English thoroughbred and related breeds than in other horses. Colles believes it may then be aggravated by sporadic vigorous exercise followed by rest, which might cause first an increase in the "capillary-bed" in the bone, and then allow the blood to stagnate in these tiny capillaries when the horse rests, encouraging thrombosis. These are only theories, but they are theories he would very much like to put to the test. □

The watery past of Mars

Two years after they landed, the Viking spacecraft are still working on the red planet and scientists are trying to answer new questions about Martian history

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About a dozen terrestrial vehicles have sped by, orbited around, crashed on, or soft-landed on Mars. They have apparently answered the "big question" about Mars. The answer is: no, Mars does not have life. Mars is deader than a door nail. Door nails presumably have some complex organic molecules on their surfaces, while Mars has none, (that is, less than a few parts per billion.) But Mars still poses exciting questions on the frontiers of research, with broad implications. Current interest in Mars can be summed up by saying that the planet offers evidence of a past with more surface water, more erosive activity, and more atmosphere, although it offers no evidence of life.

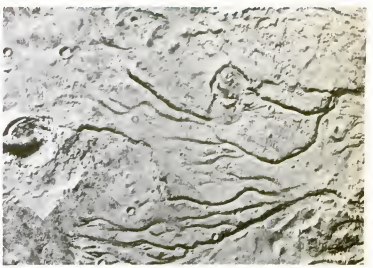
Mars may have been better suited to life in the past. Although Mars is arid today—with no surface pools of water and only about 10 to 100 micrometres (millionths of a metre) of precipitable water vapour in the entire atmosphere—it bears evidence of running surface water in the past. In 1971/1972, the spacecraft Mariner 9 discovered that Mars has a great many channel-like features that seem to be dry riverbeds. These features have nothing to do with the so-called Martian canals, which were found in a few instances to be canyons or streaky dust deposits, and most often to be illusory. The newly found channels grow wider and deeper as they run down-hill, they have tributaries, they have streamlined erosional features, and they often empty into broad, flat plains.

After a few years of trying other theories of origin, such as lava channels or wind erosion, geologists have concluded that the channels were cut by water or a fluid very much like water. If Mars had water in the past, and perhaps a warmer climate, and if complex organic molecules have evolved on other planetary bodies such as the parent bodies of meteorites why, then, didn't life evolve on Mars? Or did it evolve and perhaps die out? This line of questioning has shifted attention away from the question of life on Mars to another broad problem with important implications for understanding the Earth.

The new interest in Mars revolves around the origin of the channels, the amount of water on Mars, and the history of the Martian climate. Mars is so cold today that most of the water is permanently frozen, although small amounts sublime to form water vapour which cycles through the atmosphere and forms occasional clouds. The total amount of water that cycles seasonally through the Martian atmosphere is only about one cubic kilometre, but the volume of the water-eroded channels is at least 1000 times larger than this.

Where is the water that cut the channels? Some of it is frozen on polar ice caps on Mars. The Martian atmosphere is almost entirely carbon dioxide, which freezes out in the winter and forms broad polar caps extending to middle upper lattitudes. But, in the Martian summer, the carbon dioxide frost cap dissipates and exposes an underlying permanent cap, which in the case of the north pole, is known to be water ice, although during the Viking missions, it has apparently been masked by some semi-permanent carbon dioxide frost.

How much water cycled through the atmosphere in the past? Was the atmosphere denser in the past? Today, the surface pressure is in the range of 400-1500 pascals—Earth's atmospheric pressure is about 0·1 million pascals (Pa)—depending on the Martian altitude. In higher regions, where the pressure is above 600 Pa, any liquid water on the surface would spontaneously boil away into the atmosphere, and in all regions the evaporation rate would be very fast. But, if the gases have been leaking out into space, or if for any reason more sunlight reached the polar regions and evaporated more carbon dioxide and water vapour into the air, then in the past the Martian atmospheric pressure could have been greater. If the atmospheric pressure was greater, then the Martian climate in the past could have been considerably different.



Photographs from NASA

Apparent dry river beds on Mars show evidence of water erosion

Various geological characteristics, such as a discontinuously higher degree of erosion in older craters and thick sediments partially covering old craters, not to mention the channels themselves, suggest that the climate may have been more erosive—which might imply a thicker atmosphere—in the past. Layers of sediments detected in the polar regions suggest that the atmosphere even cycled through different climatic episodes—which begins to sound familiar. We know that the Earth's climate has cycled through variations in the past: not only the very recent and frequent ice ages on a time scale of 10 000 to 100 000 years, but also long-term variations which may have affected the evolution of life and global temperatures on time scales as long as 10 to 100 million years. The death of many species, some 230 million years ago, may have involved a significant change in climate and ocean temperature, for example.

But how old are the channels on Mars? If we could answer that, we would have a much better clue as to what mechanisms caused them, and how these mechanisms related to climatic changes on Earth. Although the last flows of fluid in the channels may have been recent, in general, the channels are not as young as 10 000 or 100 000 years. Enough meteorite impact craters dot their floors to indicate that the main channel-forming activities must have been in the region of 100 million to several 1000 million years ago. Some investigators think that most of the channels formed in the first third of Martian history, although others conclude that the activity persisted until as recently as the latest third of Martian time.

Suppose we had rock samples from Mars which confirmed that warm, wet conditions of channel-forming activity occurred at exactly the time of warm periods on the Earth. If the two planets had synchronised oscillations in climate, we would have to conclude that the driving force was

external to the planets, probably a solar variation. Climatological calculations show that even small variations in the solar luminosity may have large effects on planetary climates. The discovery that the Sun drives long-term climatic variations would have exciting ramifications for stellar astronomy, terrestrial geology, and biology.

But this is speculation. What has research on the Martian channels revealed? The channels seem to be of two types. One type is large—hundreds of kilometres long, and typically ten kilometres wide—and originates in depressed areas of jumbled hills called *chaotic terrain*. Geomorphologists studying these large channels conclude that they resulted from a sudden catastrophic release of water, estimated from the channel structures to be from 10^6 to 10^8 cu.m per second. Release of this water from underground reservoirs caused collapse of the ground, explaining the chaotic terrain. Data from the Viking landers and Earth-based observations suggest that the Martian soil still contains this water, both as absorbed water in mineral grains and as a perma-frost layer of unknown depth. Several mechanisms have been proposed that might cause the rapid release of this ground water, including

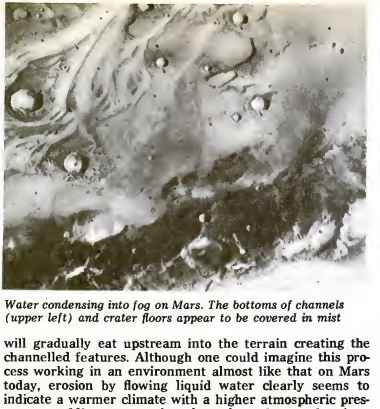
(1) local heating by geothermal activity
(2) liquefaction caused by stresses that raise the pore pressure in the soil above the hydrostatic load pressure
(3) breakout from old buried layers of water-carrying rock (acquifers), due to impact or other disturbances.

Although the slow, uniform erosion of river beds, as proposed by Hutton and Lyle, prevails on Earth in most regions, catastrophic erosion of channels by major floods is not uncommon in frozen or arid areas. For instance, a catastrophic release of dammed-up water that then flowed across the Channelled Scablands in Washington State produced features remarkably similar in scale and form to those found in the large channels of Mars.

This analysis of the large channels of Mars, contrary to our first impressions, may not require any radical revision of the Martian climate in early history. This many cubic kilometres of water is trapped in permafrost and occasionally breaks out; it simply gushes out across the landscape of loose dust and rubble, eroding a channel until it empties into a plain where it simply evaporates. Mars' climate is so cold now that ice would tend to form and perhaps protect the water from too rapid evaporation or spontaneous boiling; broken ice slabs in parts of the channel would, in fact, aid the erosion, according to terrestrial observations. On the other hand, an ancient, warmer Mars, with higher air pressure, would make this scenario more believable. A warmer Mars would keep the water liquid and more pressure—such as 3000 Pa, to 10 000 Pa or more—would reduce the evaporation rate, allowing the channels to act more like the flash floods of Earth.

Dendritic networks

The second type of channel on Mars is small, typically tens of kilometres long and up to a kilometre wide, forming dendritic networks that present a different problem. These appear exclusively in older crater terrain, suggesting that they formed some 10^9 years ago, but not within the past 10^8 to 10^9 years. They do not emanate from collapsed chaotic terrain, but seem to form networks flowing out of featureless deserts. Following the discovery of the smaller channels in Mariner 9's photographs of 1972, some researchers suggested rainfall as a mechanism for creating these features, implying, of course, a much denser and wetter atmosphere as well as a warmer climate. However, recent studies of these features suggest that they may grow primarily by *sapping*—a process of headward erosion in which the dendritic pattern fans outward from the original source. Again, this could involve a permafrost layer. If a fault or some other disturbance exposes buried ice which then melts and flows away, the sapping process



Water condensing into fog on Mars. The bottoms of channels (upper left) and crater floors appear to be covered in mist

will gradually eat upstream into the terrain creating the channelled features. Although one could imagine this process working in an environment almost like that on Mars today, erosion by flowing liquid water clearly seems to indicate a warmer climate with a higher atmospheric pressure some 10^8 years ago when these channels were forming.

A different geological observation indicating a more erosive climate some 10^9 years ago comes from the numbers and morphologies of craters on Mars. In the old, cratered terrains large craters are abundant but highly degraded, and there are not many small craters. Apparently, an erosive process acted long ago which destroyed or filled the smaller, shallower craters. Close examination of the same surfaces however, shows scattered, sharp-rimmed, fresh-looking small craters in these regions. They occur in almost the same numbers as those in the very young lava-covered areas of Mars. In other words, a new population of young craters is accumulating on the old surfaces with very little erosion occurring. Evidently, conditions long ago were much more erosive, but this erosive regime, whether episodic or continuous, eventually ended, whereupon Mars entered today's less erosive state. The "erosive regime" may be synonymous with an early period of higher atmospheric pressure.

These observations are all consistent with a generalised theory of atmospheric evolution on Mars which pictures a relatively dense primordial atmosphere gradually dwindling as light gases escaped Mars' lower gravity. For example, Viking measurements of isotopic ratios of nitrogen and other gases suggest an escape rate which, when extrapolated backwards in time, gives an initial atmospheric pressure for nitrogen alone of perhaps 2000 to 5000 Pa. Several researchers have suggested an initial total atmospheric pressure on Mars of about 10 000 to 30 000 Pa, compared to 0·1 MPa on Earth today.

Chemical measurements of the Earth, Mars and recently Venus (*New Scientist*, vol 81, p 391) suggest that these three planets all had initial gas inventories very rich in carbon dioxide, with a few per cent of nitrogen, some argon, and some water. On Earth, this carbon dioxide has disappeared into the form of carbonate rock, but is there in about the same total abundance as on Venus, which has a carbon dioxide atmosphere. Mars apparently produced less atmosphere but was again dominated by carbon dioxide. Using this simple picture, various researchers have proposed that substantially large amounts of water should occur on Mars. These amounts would be more than adequate to form permafrost, ice caps, and channels. How-

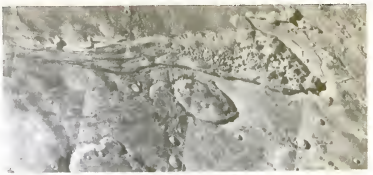
ever, the very recent measurements of water on Venus show that, unexpectedly, Venus has much more argon than its equal-sized neighbour, Earth. This result has cast doubt on any further detailed comparisons of minor constituents such as water, even though the gross atmospheric budgets may be similar on the so-called terrestrial planets.

The upshot of the discussions so far, is that Mars probably has much more water in its polar caps and under its soil in permafrost layers than we see in the present atmosphere and that this water probably ran on the surface in the past when the atmosphere was generally denser and richer in carbon dioxide and other gases.

The full story of Martian water and climate, however, has more chapters. The layered strata at the poles, combined with the other observations suggest that *episodes* or cycles of deposition and erosion occur in the polar ice and soil. In searching for a cause of episodic behaviour, researchers have examined the celestrial mechanics of Mars' orbit and obliquity (the tilt between the axis of rotation and the orbital plane). The surprising result is that the obliquity of Mars oscillates from about 12° to 38°—as much as 14° off its current value of 24°. When the tilt is very small, large amounts of water and carbon dioxide could be permanently frozen near the poles, because the poles would receive only low angle illumination from the Sun. However, when the tilt is large, the summer Sun beats down on the pole and an entire polar cap of carbon dioxide and ice could be evaporated off into the atmosphere.

What would happen geologically under these conditions is uncertain, of course, but it seems clear that the atmospheric pressure would vary and that erosive conditions would also vary at different times during these cycles. The Viking landers themselves have measured small pressure variations of a few hundred pascals during the Martian year, as the carbon dioxide frost has cycled from one polar cap to the other. Still more interesting is the fact that the dynamics of Mars were different prior to the formation of the massive dome of lava flows and the volcanoes some 25-km high that dominate one side of Mars' northern hemisphere. The dynamical calculations indicate that before this weight was added to one side of Mars, the obliquity shifted from about 22° to 45°.

The volcanoes are not old. They probably formed in the middle third of Martian time with some activity continuing until more recently. Prior to their formation, the atmosphere and its water must have behaved differently, with much more polar ice dumped as water vapour into the atmosphere each summer. Furthermore, the simple assumption that the Martian volcanoes erupted the same amounts of carbon dioxide and steam per gramme as terrestrial volcanoes, indicates that the massive pileup of lavas liberated significant amounts of carbon dioxide and water relative to the atmosphere today. Some estimates even indicate that the total carbon dioxide released would be comparable to that presently in the atmosphere! So the dynamical results and volcanic studies combined present a strong argument that climatic conditions were probably different before the volcanoes formed than afterwards. Indeed, the small channels are confined to terrain older than the volcanoes, which supports the thesis that they formed only in the different conditions prior to volcanic formation.

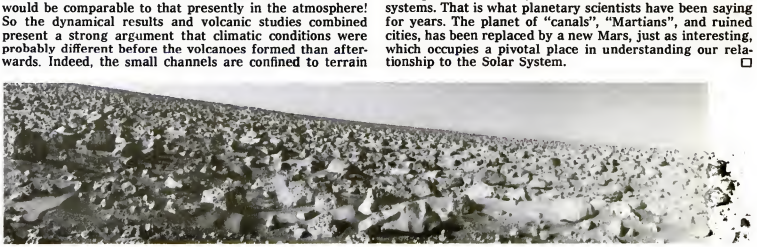


Chaotic terrain *apparently formed by collapse of underground reservoirs with channels running out towards the left*

In terms of scientific history, it is interesting that these ideas came forth during the Mariner and Viking programme at about the same time that terrestrial geologists were independently moving towards the Milankovic theory of the terrestrial ice ages—that is that the same kinds of dynamical changes in the Earth's orbit and obliquity control the ice ages on Earth. Calculated variations in temperature, as a result of changing amounts of sunlight to different parts of the Earth, correlate quite well with the climatological record of ice ages geology has revealed for the past few hundred thousand years on Earth. But the magnitude of the astronomical effects on Earth are small and rapidly changing, whereas on Mars they are large, and more slowly changing.

The three effects I have discussed—decline of a primitive atmosphere, dynamical changes, and formation of massive volcanoes—may be adequate to explain the evidence for water flow and more erosion on Mars in the past. But, the Martian data have spurred some new looks at yet another possible effect: instability in the main heat source of the Solar System, the Sun itself. During the 1970's, planetary, solar and stellar astronomers have all acquired data suggesting that the Sun may be neither as stable nor as well understood as was thought a decade ago. The failure to discover the predicted solar neutrinos is just one example (*New Scientist*, vol 80, p 780). Thus, while not proven, a suspicion still lurks that something is wrong with our knowledge of the Sun. This problem, if it can't be blamed on Mars, at least involves Martian data.

A terrestrial palaeoclimatologist at the Second International Mars Colloquium in January remarked that when he arrived at the meeting he wasn't sure his presentation would be relevant. But within a day, he was convinced that Mars was bringing a fresh insight into terrestrial problems, such as astronomical influences on climate, atmospheric structure, and formation of river channel systems. That is what planetary scientists have been saying for years. The planet of "canals", "Martians", and ruined cities, has been replaced by a new Mars, just as interesting, which occupies a pivotal place in understanding our relationship to the Solar System. □



Dissection of Fleet Street's disasters

Problems caused by the introduction of electronic "new technology" into national newspapers have taken *The Times* off the streets and threatened the survival of the *Daily Mirror*.

Duncan Campbell is science and technology correspondent of the *New Statesman*

The Times and *Sunday Times* have now spent seven deadlocked months trying to reach agreement between management and print unions over the introduction of a sophisticated £2·5 million computer typesetting system. Down the market a little way, the *Daily Mirror*—which planned four years ago to lead Fleet Street's new technology revolution—has just written off the capabilities of its computer system to perform any more than the simplest tasks, and has lost millions of pounds through failures of technology. Behind the disasters is the failure of over-eager systems-analysts—and some newspaper managers—to realise quite how complicated both the newspaper product and the system of production are.

The new technology of printing is focused largely in only one section of the whole newspaper process: the job of converting the journalists' or advertisers' words into a form in which they may be reproduced by printing presses. Although their jobs may be altered, the journalists and printing press workers will remain. The brunt of any changes in the industry has to be borne in the areas of typesetting—turning typescript or manuscript into blocks of type—and composing—assembling the blocks of type and any illustrative or display material into a full page. In these areas, computers and electronics have already had a deep impact. In the most sophisticated form of system, journalists and advertising clerks might insert their material directly on the computer video display units (VDUs); subeditors and others would electronically view the proposed layout of a page; once this was complete, a photosetting machine would convert the electronic image of the page to a copy on photographic film or paper, which then goes on to the presses.

But the problems of today are not so much related to such electronic fantasies as to the technologies of the past. The fundamental machinery of printing—until recently—was the Linotype, which, one line at a time, moulds molten "hot" metal into a line of type. Operating a Linotype machine is a complicated business, and is a very highly skilled, and on Fleet Street a very highly paid, trade.

Just over 100 years from the original invention, in 1872, of the Linotype by one Ottmar Mergenthaler, the US corporation which he founded, Mergenthaler Linotype, sold the Mirror Group of Newspapers a system which would eliminate the old Linotypes altogether—as well as a considerable number of jobs. The Mirror Group development plan, announced in July 1975, aimed to convert all the group's newspapers—including the *Sunday People*, *Reveille* and the *Sporting Life*—to fully computerised typesetting by the start of 1977. The cost of the plan was £2·8 million for equipment alone, although £7 million more was set aside for redundancy payments to staff.

The heart of any such operation is photosetting equipment. This type of equipment began to be used in a substantial way during the 1960s, and gradually increased in sophistication. Instead of operating the hot-metal Linotype machine, the operator uses a typewriter or similar keyboard to transfer the text to punched or magnetic tape, or some other storage medium. The text is then set photographically.

Photosetting has been introduced successfully in many magazines and provincial newspapers, and even in parts of the national newspaper business. To obtain the final page, the film of type emerging from the photosetter is cut up and pasted down onto a final layout sheet. Headlines, illustrations and photographs (after being "screened", that is turned into dots) are pasted down to make an image of the desired final page. This method of composition, which replaces the rearranging of metal lines and blocks of type, is aptly known as "cut and paste".

Electronic composition still impossible

The *Mirror*'s intended revolution was not to introduce photosetting, but to convert the entire composition process to be all electronic. That revolution has wholly and expensively failed, and the *Mirror* and UK Linotype agent Linotype Paul are still arguing about who shall take the blame. It has not yet proved possible to perform fully electronic composition for a British national newspaper, largely because of the need for extreme sophistication, speed and reliability in the software. No one has yet generated software which will do all the work required, on time.

The *Daily Mirror* system design incorporated two new developments intended to be a sizeable leap ahead from ordinary photocomposition; automatic page composition (APC), whereby the stories, headlines and text would be shaped, edited and laid out on a page totally electronically; and full page composition (FPC), which additionally included the digitisation of all pictures so that they too could be included in the process.

The software required even for basic photosetting is not inconsiderable. Not only has the right type shape and size to be selected, but each line must usually be justified by spacing out the words on a line to line up at both left and right hand sides (as with this article). Moreover, the computer has to know how and when to hyphenate words that have to be broken in two. A typesetting operator's basic command of language makes this a straightforward part of setting skills. But a computer must hold a hyphenation routine, with sets of explicit rules and backup tables of exceptions to the rules.

APC requires not only those programs, a full range of software for editing text, establishing a basic page layout and then jiggling everything to fit, but it must also control and regulate the operation of a large range of peripheral devices involved in the process. The *Mirror*'s plans would involve preparing an average of 420 tabloid pages a week, which requires linking up about 60 peripherals to computers and the associated equipment.

The setting work starts with some 28 keyboards, which replace the conventional Linotype operator. Nothing can be done from these positions except to insert text. After entry, the text is then transferred to one of about a dozen page make-up stations. These each have a page view terminal (PVT) which should display the entire page as it will eventually appear, and a VDU, known by its commercial title of LSK, for carrying out text manipulation on the copy. Two operators man each position, often joined by a third to coordinate their work. The journalist sub-editor actually responsible for the page has then to peer over their shoulders (if union rules allow), or await a copy on paper to inspect.

The way in which the page composition team muddled its way up from the traditional one or two (a hot metal compositor and sometimes a journalist sub-editor) to four is an indication of how ill-thought out the systems design had been. Although there *were* overall savings in staff, the process of page editing became infinitely more

If management get their way, and unions allow it, clanking old Linotype machines will be replaced with shiny new computers

laborious and time consuming.

The page view terminals were very poorly matched to the working methods for final editing of a newspaper page. From the start, it was doubtful whether the terminals could ever display photographs and drawings electronically, but could only indicate the shape of a space allocated to a picture. The terminals did not have sufficient resolution for compositors to read the stories without a magnification routine which put the rest of the page out of view. Anything set in 9 point type or smaller (the same as that used for this article) was unreadable. In a ludicrous example of the technological tail wagging the newspaper production dog, the *Mirror* management at one stage seriously proposed to replace the unreadable lines with lines of electronic blobs—to "avoid eye strain" when printers tried to read the words. The terminals, it was claimed, would still give an "impression" of the newspaper page—even if the printers and journalists couldn't check the words!

Once an acceptable page has been assembled on the PVT, it can be generated by the photosetting equipment, a Linotron 606, and taken off to be printed. The manufacturers, Linotype Paul, had promised that a new, fully electronic system for inputting all pictorial material electronically would be available by 1977. But the graphic input terminals, chosen to the *Mirror*'s specification, have never worked at all. As a result, all illustrative material, including advertisements and large "white on black" headlines have to be set the traditional way and then pasted on to the Linotron 606 output. The actual final output page, as a result, is normally mostly blank.

The voids on the "finished" APC pages were perhaps the biggest indication of how seriously the system designers had got it wrong. Linotype Paul proudly boasted how the 606 could churn out 3000 newspaper lines a minute—fine for something with the typographic simplicity of a telephone directory, but pretty irrelevant to most magazines and newspapers, particularly the sort of layouts used by British popular tabloids. It mattered little that the entire newspaper's word content could be spewed out in a couple of minutes when vital hours were lost because the system couldn't manipulate the words and headlines efficiently.

Racing ahead

The *Mirror*'s plans—and Linotype's promises—were sufficiently far ahead of their time to trip everyone up effectively. The Linotron 606, said to be the fastest photosetter in the world, did not show its face in Britain in public until November 1976. That was some time after the first of the Mirror group papers, *Reveille*, was supposed to have converted to new technology. Neither the PVTs nor the graphic input scanners were available in production when the *Mirror* placed its order in 1975. Electronic graphics systems had already flopped at least twice in the hands of other manufacturers and newspapers—even IBM had lost out.

Curiously, the International Publishing Corporation, which then owned the *Mirror* and still owns *New Scientist* (the *Mirror* having been detached to a separate company in the same group), had its own research and development group working on APC and FPC for some six years

up to 1974. It had developed a working APC system, which it told the *Mirror* might be ready in three years. The *Mirror* management found this unacceptably long and went to Linotype Paul who were unwary enough to promise the goods within 12 months. The IPC research and development team quickly broke up, most of its staff refusing to become involved with the *Mirror's* precocious plans. Ironically, many of them are today in an independent company, Pica Computing, which is now finalising the software for the next Fleet Street new technology system, on the *Observer*. This is a much more cautious and restrained development involving straightforward photosetting without direct input to bypass the printers. The new system, called CS7, should be working by the end of the year, the main difficulty being that the *Observer* has almost doubled its size in the absence of the *Sunday Times*.

Leaving aside the complexity of tabloid layouts, the big problem about full APC with pictures is the massive amount of digital data involved. Although storing the data (on magnetic disc store) is relatively easy, trundling it around for layout operations in a small computer system will overload an already slow system.

Lack of computer power

Both the *Mirror* and *The Times* computers, are, it seems, somewhat underpowered. The *Mirror* uses Prime 100 minicomputers, one built in to each Linotron 606, and one system machine outside. *The Times* uses similar minicomputers made by Hewlett Packard. The *Mirror's* experience clearly points to a chronic lack of computer power. Although the newspaper and the manufacturers may argue about whether an operator's lack of experience or poor software is responsible for a particular failure, it is clear that when pages sent into the "copyfit" routine (part of Linotype's "System V" software) disappear for vital hours, the software is too slow. It is worth remembering that these systems are often intended not only to handle the page and type setting, but also to keep track of the insertions required for classified advertisements, and perhaps sent out the bills as well. (*The Times* has a small ICL computer linked in, which is to handle most classified advertising and accounting work.)

In different ways, the new technology has led two newspaper groups to the brink of disaster. At *The Times*, a dogmatic management, which had determined to abandon the philanthropic "prestige" support of *The Times* for a profit-making product, demanded that unions agree to work with the new equipment on management terms, despite the effect on working conditions and the redundancies involved. The unions, traditionally strong in Fleet Street and not willing to dig their own graves, said no, and the management of Times Newspapers blundered on into last November's closure. The most critical issue for the print workers is whether they retain the job of entering the text into the system, or whether these jobs are taken over by advertising clerks, typists and journalists, who are then performing "direct input". At the *Mirror*, all input is still handled by print workers although direct input is now used at a number of British provincial newspapers which have adopted computer-based photosetting.

The Times has similar problems to those at the *Mirror*. Although it does not provide APC, except for the simple classified ad pages, it is intended to output stories that have been shaped to fill the page. The full software on *The Times* has, of course, never been put to the real test, but operators have already discovered grave defects. Although the photosetters can print accented letters, the computers controlling them cannot; *The Times* readers' café threatens to degenerate to a cafe.

Serious defects in both *The Times* and the *Mirror* system include the lack of a real time clock, which helps keep track of when vital pages and stories must be output. There is also no system of check digits on the layout instructions, which are helpful in preventing unfortunate text transpositions. *Mirror* journalists recall with embarrassment how their sports pages made up on new technology once included, mixed in, advertisements for the price of knickers.

The *Mirror* has not been without its share of labour problems, both from journalists and printworkers. But a relatively amicable solution for new technology arrangements was reached last year, and conversion to the Linotron/computer system began.

In January 1978, the first of the Mirror group papers to convert to new technology began switching processes. After a month of major problems, most of the weekly *Reveille* was being handled by the computer system. But it was the easiest possible task—a weekly paper with no critical news deadlines, plenty of time to spare—and plenty of unused capacity on the computer. And, of course, the absence of the graphics facility meant that large empty spaces on the output copy had still to be filled with illustrations and headlines by hand.

In May, the daily *Sporting Life* broadsheet attempted to convert to new technology. On the first day, a Sunday, not one page of the paper could be produced. Even two days later, when some errors had been cleared up, the staff failed in a trial exercise to get four of the paper's pages ready in time. The *Sporting Life* was off the streets for a week, and went back, permanently, to hot metal. Plans to convert the other papers overnight were also abandoned.

Then, from November 1978, the *Daily Mirror* began to convert from hot metal to computer setting, planning to complete the changeover by May this year. The result was an escalating disaster. Pages could not be finished in time, resulting in delays in the critical printing and distribution processes, and consequent subsequent loss of sales. Worse, instead of losing staff, the problems of running two separate systems meant that the *Mirror* had to employ more, not less, staff—and all at the substantial wage rates, now in excess of £200 per week, which had been negotiated as a *quid pro quo* for the loss of jobs. By the end of April, the *Mirror* knew they were heading for financial disaster unless something was done to curb the losses caused by the computer system problems. Additional production costs had soared to over £5 million in 1978/79 and the coming year was looking twice as bad.

The solution was drastic but workable. Graphic input terminals, input keyboards (which were "blind"—the operators could not properly check their work), page view terminals, and APC were all abandoned as white elephants, leaving the system merely to do typesetting, followed by the "cut and paste" work. Although Linotype Paul will continue trying to make the system meet the Mirror Group's requirements, few now expect to be around for the "revolution".

The blame for the disaster seems to lie more with the blinkered technological determination of the *Mirror* management than with the too ready promises of Linotype Paul. From the start, the *Mirror* determined the direction the development would take, and now are even buying up numbers of Linotype Paul's own project staff to tinker about with the software to their own requirements.

The lesson to draw is not that all the technology does not work, for much of it does. But overeager computer and printing salesmen, together with newspaper managements who increasingly see themselves as managing just one more profitable product line for multinational companies, have oversold their abilities to equip or manage national newspapers, and undersold traditional skills and sensibilities. The original 1970s "crisis" of Fleet Street that started the fuss about the new technology revolution—largely over escalating newsprint prices—has been solved. It is ironic that it has left a further, unnecessary, crisis in its wake. □

Monitor

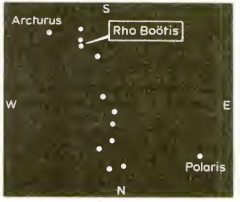
Astronomers respond slowly to variable star

Hot on the heels of the discovery of the supernova in the galaxy M100 by American amateur astronomer Gus Johnson, a British amateur, Colin Pither, recently produced evidence that a star, visible to the naked eye, is an unsuspected variable. Most amateurs have now heard the news, but they haven't got access to equipment to confirm it. And they are not sure enough to alert professionals—who could check—in case they lose their reputation for providing useful reports.

Pither was taking a break from his telescopic observations at his observatory at Charminster, near Bournemouth, on the evening of 19 May, when he noticed something odd about the constellation patterns: after a moment's puzzlement he realised the star Rho Boötis was brighter than normal.

Following usual practice, he telephoned other amateurs to seek confirmation, and the result from local experienced variable star observers was mixed. Dave Branchett from Eastleigh was unconvinced that the star had changed, whereas Mike Swan, at Wimborne Minster, agreed with Pither.

From his own and other amateurs' observations over the following weeks, Pither deduced that Rho Boötis is varying with a period of six days, and its slow fade and rapid rise indicate it to be a cepheid variable—yellow supergiant stars 5 to 10 times as massive as the



Sun. Pither presented his results at a meeting organised by the nova patrol of the prestigious amateur magazine *The Astronomer*, and on local television.

If the star is varying, it is one of the brightest cepheids in the sky, on average brighter than the prototype Delta Cephei itself, whose variation was discovered over 300 years ago. The variation of Rho Boötis in brightness is only half that of Delta Cephei; in astronomers' terms, Pither estimates it varies between magnitudes 3·78 and 3·36. Such a small variation in brightness is difficult to judge accurately by eye—some might say to detect at all—through the traditional amateurs' method of comparison with nearby stars. Professional photoelectric measurements are essential to assess the magnitude of the variation.

On the night of the discovery, Pither contacted Robert Argyle of the Royal Greenwich Observatory, Herstmonceux, but the telescopes have their week planned months in advance and none is currently fitted with a photoelectric photometer. Argyle intends to use the observatory's 13-inch refractor to obtain photographic measurements of the star's magnitude, with a filter to reduce the light of Rho Boötis a hundred times to allow comparison with faint stars.

Other observatories will not make photoelectric observations unless they are notified via the International Astronomical Union's circulars. This highlights one of the problems amateur astronomers face in their relations with professional astronomers. As the variations are so near the boundaries of visibility, leading amateurs, such as the editor of *The Astronomer*, which coordinates nova and supernova patrols in this country, are unwilling to alert the world's observatories on what may turn out to be a cry of "wolf!" as this could endanger the reception of subsequent nova or supernova reports. And if this is a regularly-pulsing cepheid, it isn't essential to follow up the amateur's measurements immediately. Yet left to the vagaries of eye-comparisons, there will not be unambiguous confirmation that this is a new cepheid. □

Kids don't understand profit and loss

Exasperated parents will not be surprised to learn that children do not exercise their logical faculties very hard unless they have to. Gustav Jahoda, professor of psychology at Strathclyde University, has found some curious gaps in the reasoning of 6 to 12 year olds about how a shop is run (*European Journal of Social Psychology*, vol 9, p 115).

Jahoda studied children from a poorish area of Glasgow in a mock shop he set up for the purpose. The children had to act out various roles including that of a shopper and the person working behind the counter.

One of the first questions Jahoda set out to answer was whether the children had any concept of profit and that the shop had to make some. In the shop, there was a telephone. The children were told that the shop had sold out a certain item which they had to sell at price X. It was the children's job to order some more items from the supplier. Jahoda wanted to see if the children understood that they had to try and buy these items at less than X so that they could sell them at X for a profit.

Nearly all the children ordered the goods up on the play telephone without any thought of profit. Only 5 out of 15 of the 11 to 12 year olds, the oldest of the children tested, made any attempt to get the items for less than the price they knew they would sell them for.

Did the children know where the money to run the shop and pay the wages of the staff came from? Jahoda found that the children knew quite well that the staff in the shop had to be paid. But when the children were asked where the money came from, they produced answers such as: "from the till", or "from the bank", or "from social security".

When Jahoda explained to the children that the money which the shop paid to the staff and for rent had to be earned, all the children grasped the logic of that. But they found it harder to understand where the extra money came from. The study also discovered a curious notion the children had about the manager of the shop who, in the mock setting, was in the background. Most of them did not appear to think he had to be paid by the shop—some children thought "the social security" paid him.

Jahoda stresses that what this study does not show is that the children are deficient in logic. It is just that even quite "old" children fail to apply their logical faculties to specific situations. The experiment is also interesting in that it tackled the problem in a very intriguing quasi-naturalistic way. The results certainly suggest that psychologists could generate an endless string of anecdotal results by studying the matter further. How they can put it to good use remains to be seen. □

Cells lightened of their contents

American biophysicists and opticians have developed new equipment that can measure the levels of adenosine triphosphate (ATP)—a crucial chemical in metabolism—in individual cells. Such research could help to establish whether, as biophysicists now believe, changes in cell ATP levels are linked with the hardening of the red blood cells. When red blood cells harden they cannot pass through narrow blood vessels to supply oxygen to the cells.

R. S. Kostuk of the US Coastguard Research Center at Groton, Connecticut, and A. G. Muhs, F. H. Kirkpatrick and C. W. Gabel of the University of Rochester, New York, devised the system, which consists of a microscope, a laser, and a photon counting system (*Applied Optics*, vol 18, p 1527).

The operator selects a blood cell, and ruptures it with the laser gun. The cell contents mix with a surrounding medium that causes immediate bioluminescence; the amount of light released indicates how much ATP was present in the cell. Up to now, biophysicists have had to use a million cells together to measure average ATP levels.

With the microscope, the operator can pick out individual cells with abnormal physical characteristics for analysis. So far the developers have used the system to follow biochemical reactions. □

Monitor

continued

Piglets gain protection from gut infections

A new and radically different approach to the prevention of one of the most important gut infections of the pig has emerged from research at the Unilever Research Institute in Bedfordshire. The new system, already going into active service on farms, relies not on the mass medication of the pigs with antibiotics (heavily criticised in recent months) but on stimulating the pigs' own defence systems (*Veterinary Record*, vol 104, p 494).

The disease in question is a form of severe and often lethal diarrhoea of young piglets caused by some strains of the familiar bacterium, *Escherichia coli*. This bug is found in the faeces of almost every animal, including ourselves, in vast numbers. In the colon, where it belongs, it does no harm. In a young piglet though, which has not yet developed an acid stomach, which acts as a barrier against infection, *E. coli* can get into the upper reaches of the gut, if the piglet snuffles around in its mothers dung. The results can be catastrophic, and the problem is made even worse by the fact that the mother's excretion of *E. coli* soars with the stress of giving birth just when the newborn piglet is most at risk.

In the past, attempts to help the piglets over this period have centred on vaccination of the sow by injecting her with particles of dead *E. coli*, in the hope that she will make antibodies to these. Like all farm animals, the baby piglet receives all its antibodies from mum in the colostrum, the first milk it gets after birth. The problem is that the antibody found in the milk after injection, although plentiful, is not of the type most useful to the newborn pig. One way to get the correct antibody class was to give the sow the *E. coli* in her food, to stimulate her immune system via the gut, but this increases the level of excretion of the bugs on the farm, one of the things the farmer wants to reduce.

The new scheme, reported by J. Chidlow and P. Porter from Unilever, is a two-pronged attack on the bacteria, and is proving very effective. The sow herself is fed on the extracts of killed *E. coli*, before she gives birth to her litter. This is followed by one injection of the same "vaccine". The result is that the antibody level in the colostrum is of the right type (IgM) and at double the level of sows who simply had the conventional injection. The piglets are not only better protected, they also receive a far smaller challenge to that protection. The obvious question is, does it work?

Field trials of the new system are impressive. The sows treated with it showed only marginal disease, one piglet out of 43 dying. Of the control group, with no vaccination, 76 per cent of the piglets died of "white scour" caused by *E. coli*.

This new system is unique in that it still permits the presence of *E. coli* in the gut, which allows the animals' immunity to develop, but prevents the bugs from producing disease. Antibiotics can certainly kill *E. coli* but they then leave the pig wide open to future attack. With the current concern over drug-abuse in the farming world and fears over the development of antibiotic resistance in bacteria, this new system is bound to be widely taken up by conscientious pig farmers. □

We are not alone

Somewhere in the Universe, there may be a replica of you, reading a replica *New Scientist*, open at a Monitor report headed "We are not alone". This bizarre possibility is the inevitable conclusion drawn by G. F. R. Ellis and G. B. Brundrit from the observational evidence that the Universe is "open".

Most cosmologists now accept that the Universe as we know it started out in a big bang, some 20 000 million years ago, and what evidence there is suggests that it will keep expanding forever. This means that although the Universe may have started out from infinite density in the big bang, it was not infinitely small (zero volume) but always infinite in extent. In other words, the infinite Universe is expanding and getting less dense but always was infinite in size and always will be.

Ellis and Brundrit, of the University of Cape Town, have now pointed out some obvious, but apparently previously overlooked implications of this (*Quarterly Journal of the Royal Astronomical Society* vol 20, p 37). Using the usual mathematical description of the Universe, there must, if the Universe is infinite, be an infinite number of "world lines" representing galaxies. So there must be an infinite number of galaxies. In that case, if there is any finite chance of life developing on a planet in one of those galaxies, then there must be a literally infinite number of planets bearing life in the Universe—and we know for sure that the probability of life existing is non-zero!

How like us might other life forms be? On at least some of the infinite array of planets bearing life, conditions must be like those on Earth. And any sub-set "some" of the infinite set must itself be infinite. So there are infinitely many planets very like our own on which evolution is related to the DNA molecule. But the patterns of variability of DNA are finite, though large. So there must be infinitely many planets on which creatures which carry *exactly* the same genetic material as ourselves exist. And as a subset of this infinite array, there must be an infinite number of worlds with the same history as the Earth.

Assuming that there is life in the Universe, Ellis and Brundrit offer only one way out of this multiple-twinning scenario. The Universe must be "closed", dense enough so that gravity wraps space-time around within a finite volume, like a super large black hole. This is an unfashionable idea today, but perhaps the puzzle posed by the two Cape Town theorists will make some cosmologists think again. □

Spit heals skin wounds

Lick your wounds! It really will make them heal faster, according to a team at the Royal Children's Hospital in Melbourne, Australia.

J. M. Hutson, M. Niall, D. Evans and R. Fowler made a small cut in the skin at the centre of the back in a number of mice. The wound was placed so that the mouse should not lick the cut itself. The mice were then caged, either alone or in small groups, and the size of the wound measured every two days. The grouped mice, who could—and did—lick each other's scabs, healed much faster than those in solitary. This suggested that there was indeed something about licking that enhanced healing. Was it something in the saliva?

The next step was to remove the salivary glands from a group of mice and compare them with intact mice. There are three main pairs of salivary glands; the parotid glands, near the ear; the sub-maxillary glands, along the edge of the lower jaw; and the sub-lingual glands, below the tongue. Removing either the sub-lingual or the sub-maxillary glands slowed the rate of healing considerably, but removing the parotid glands had little effect.

So although the Australian researchers still do not know what it is that promotes faster healing, they do know that it is present in saliva from the sub-lingual and sub-maxillary glands, but not in saliva from the parotids. Isolating the factor that promotes scar healing could be of enormous benefit, as the healing process seems to be similar in all mammals (*Nature*, vol 279, p 793). □

Body molecule fights stress

A team of American scientists may have pinpointed the body's own remedy for stress and anxiety. Phil Skolnick and his colleagues have shown that the receptors that react to anti-stress drugs such as the benzodiazepines (which include Librium and Valium) can also be activated by an endogenous chemical called inosine, and one of its derivatives. They carried out the work at the National Institutes of Mental Health and Alcohol Abuse and Alcoholism in Maryland.

The story closely parallels the discovery four years ago of the enkephalins —the body's natural pain killers. In each case researchers showed that a particular range of drugs could ease the symptoms—and then looked for the places in the body where the drugs were taken up. Danish researchers found the receptors for the anxiety drugs two years ago, and this sparked off a rush to look for any chemicals made by the body that might activate them.

This search is now pretty well over, thanks to the efforts of Skolnick and his colleagues. They first suspected that inosine could be involved when they found last year that the substance attached itself to benzodiazapine receptors in extracts from cows' brains.

The researchers went on to check the effects of inosine by injecting the substance into mice, which were going through artificially induced seizures that normally led to convulsions and often death. The onset of convulsions was considerably delayed by the inosine, which was injected straight into the ventricles that carry cerebrospinal fluid round the brain *(Proceedings of the US National Academy of Sciences*, vol 76, p 1515).

These results are of key importance and should lead the way to an intense investigation into how molecules native to the brain control the balance of our mental states. Research just completed at the London School of Pharmacy on an "anxiogenic" effect of the classic hormone, adrenocorticotropin, shows that in brain cells it produces effects opposite to those of benzodiazepines (*British Journal of Pharmacology*, vol 66, p 115P).

The discovery of the enkephalins four years ago was followed by an explosion of research into their involvement in analgesia in the nervous system, which resulted in major advances in the chemical control of pain relief. This episode may now well be repeated in another fascinating area of human behaviour with even greater clinical implications.□

Comets move on solar-powered jets

The Sun turns comets into miniature jet engines that move inwards and outwards in the Solar System under its influence. This is the conclusion of Paul Weissman, of the Jet Propulsion Laboratory in Pasadena, California, who has been looking at how comet orbits are affected by the scorching the comets' nuclei receive as they pass the Sun. He has shown that this effect is large enough to explain how comets with very elongated orbits—stretching to the fringes of the Solar System, one sixth of the distance to the nearest star—are deflected into short-period orbits among the planets within just a few periods (*Astronomical Journal*, vol 84, p 580).

When cometary nuclei come close to the Sun, the ices on the Sun-facing surface are vaporised and enter the comet's tail. As a result of the loss in mass, the comet is accelerated in the opposite direction. Actually the effect is more subtle, because the heat takes time to evaporate the ices. Before some of the gases flow away, the nucleus will have rotated so that the heated side does not precisely face the Sun. Depending on the direction of rotation of the nucleus relative to the Sun, the comet will be slowed or speeded up in its orbit, as well as pushed away, from the Sun.

Suppose a nucleus is slowed down by this process. Then it will not get so far away from the Sun before it reaches the turning point of its orbit as it did the last time. Its orbit has changed, bringing down its average distance to the Sun. A few more circuits, and its orbit may have completely changed.

The same applies to comets rotating in the opposite direction. These pick up speed, and so get farther and farther away each time. Eventually, they are ejected from the Solar System—never to return.

Weissman's works throw light on the unexplained origin of the Kreutz family of Sun-grazing comets. These eight brilliant comets move in almost identical highly elongated ellipses which pass within half a solar radius of the Sun's surface and move out to about 100 astronomical units at aphelion. (An astronomical unit is about $1{\cdot}5\times10^{11}$ metres—the average distance of the Sun from the Earth.)

Hale Observatories

The Sun-grazing comet Ikeya-Seki moves tail-first away from the Sun in October 1965 after passing within half a million miles of the Sun's surface

Kreutz comets are fragments of a massive comet which suffered repeated break-up close to the Sun during several revolutions of its orbit.

The parent comet of the group must have been formed in the Oort comet cloud way out at 40 000 astronomical units from the Sun, and perturbations alone could never reduce this to only 100 astronomical units in such a short time. However, the observed Kreutz group members pass so close to the Sun that the forces due to the jet mechanism must be very large and could easily reduce the aphelion distance from 40 000 down to only 100 astronomical units in only two or three revolutions of their orbits. □

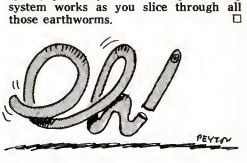
Earthworms need painkillers too

Lowly cold-blooded creepy-crawlies may actually feel pain in much the same way as mammals. This is the implication of a new and unexpected discovery by a group of Swedish researchers, which has found that the common garden earthworm possesses substances that deaden pain, and the receptors that these chemicals activate (*Nature*, vol 279, p 805).

J. Alumets, R. Håkanson, F. Sundler and J. Thorell, of the University of Lund, have identified chemicals in the earthworm that are very similar to enkephalin and beta endorphin. These two chemicals belong to a group called "natural opiates"—they perform the same role in the body as pain-killing drugs, but are made internally.

All vertebrates probably have endogenous opiates and the receptors that detect these and block pain. But research results published in 1976 made it seem unlikely that invertebrates had the same kind of system—in other words, invertebrates did not posses a nervous system able to relieve pain. This supported the gut feeling of unfeeling humans that "lower" animals, such as worms, do not feel pain.

The Swedish team noted that there were chemicals related to the endogenous opiates in earthworms, and decided that a search for the opiates themselves was worth a try. And they succeeded. Earthworms do have opiates, so they must have pain to block. Next time you go out in the garden with a spade, just hope that the pain-killing system works as you slice through all those earthworms. □



Technology

Digital communications come to the battlefield

Tomorrow's infantrymen will be, in effect, walking telex operators. The importance is not so much that soldiers in the middle of battle will be able to transmit and receive messages in written rather than verbal form, but that they can send their messages coded as binary signals over the radio waves. Binary messages can be sent faster, more accurately and with less chance of detection than messages transmitted by conventional analogue equipment.

Plessey last week became the third British company to announce it has made digital communications equipment for the battlefield. Racal and Cossor have already told military purchasers that their hardware is available. Plessey's equipment is a £3000 message terminal which can be used with an ordinary mobile radio.

The invention of the "walkie-talkie" backpack radio greatly increased soldiers' ability to communicate with each other. But radio waves which carry voice traffic are invariably in analogue form while binary coding is much more suitable for the special conditions of the battlefield. The problem is that it is difficult and expensive to turn voice waveforms into a binary form for radio communications: doing the same to typed or written messages is much easier, because written characters and numbers are easier to turn into a sequence of binary digits than the constant rise and fall in tone of the voice.

Soldiers get the message

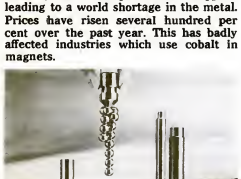
So the obvious way of improving battlefield communications is to send messages as a coded waveform representing script. However, carting around the necessary teleprinter equipment never looked a very attractive proposition. (Nor did the idea of translating the verbal message into Morse—a form of binary code—and transmitting it as "dots and dashes" over the radio waves.) The new equipment capitalises on small electronic components to provide an easy way of turning words into binary code.

In the Plessey system, the soldier carries a small box of electronics containing a miniature keyboard and display screen and also a microprocessor. The man types in his message, which will normally be less than 100 characters—for instance defining the positions of enemy artillery. The microprocessor translates this into the 0s and 1s of the binary format. These are then transmitted over the radio waves with the 0s represented by one audio frequency and the 1s by a second. A computer memory records the message for later reference: when the soldier receives information from a counterpart the incoming message is displayed on a screen. □

Magnet attraction

The Japanese company Matsushita has developed a new magnetic material, made of readily available metals, which could offer an alternative to cobalt as a base for lightweight, high-energy magnets.

The political upheavals in Zaire, where many of the world's cobalt mines are located, have disrupted cobalt supplies leading to a world shortage in the metal. Prices have risen several hundred per cent over the past year. This has badly affected industries which use cobalt in magnets.



The new magnets are easy to shape

Matsushita, which has worked on cobalt-free magnets since 1968, says that a mix of manganese, aluminium and carbon gives 30 per cent more magnetic energy than an equivalent cobalt-based magnet of the same weight. The company has not specified the percentage in the mix. Magnets made of the new material can be easily shaped on a lathe and are difficult to break. □

Strike a light to reduce energy

General Electric of the US has developed a household light bulb which it says lasts up to five times as long as a conventional bulb and uses a fifth as much power. The lamp owes its low energy consumption to a tiny gas arc. This is instead of the incandescent filament that provides light in ordinary bulbs. The lamp, which will go on sale in Europe in 1981, will cost £5, about 20 times as much as standard light bulbs. But General Electric says it would pay for itself in the long run by decreased electricity bills.

The source of light is a glass sphere of about 1 cm in diameter. This contains two tungsten electrodes and is filled with a gaseous mixture of metal halides, mercury and argon. An arc is formed between the electrodes to give an even white light.

Arc lamps are usually made from elongated bulbs drawn into a tube. These form dark patches along their length. The cause is electrophoresis, which is the movement of charged gas particles towards an oppositely charged electrode. This has the effect of "bunching up" the particles into luminous patches, leaving other areas dark. The uneven brightness makes these lamps unsuitable in houses. (They are, however, used in sports halls, theatres and so on.) GE engineers say electrophoresis is not a problem in their arc lamp because the bulb is very small and has specially designed electrodes.

Like most arc lights, the new lamp uses less power than an incandescent lamp. But arc lights take a few seconds to warm up. So when the lamp is switched on, "instant" light is provided by a conventional filament, which extinguishes when the arc reaches full brilliance.

The new bulb contains special circuits, called ballast, which boost the mains voltage to a level high enough for the arc to strike. GE has also added electronics which will keep the illumination constant if the voltage fluctuates. □

Giant screen for TV

General Electric of the US has made a domestic colour-TV set with the largest screen to be marketed in any country—94 cm by 69 cm. Although this picture size is achieved by a projection system, the set looks like an ordinary television.

Most projection TV systems operate in one of two ways. The viewer either has to place a bulky projector unit in the middle of a room facing a large wall screen, or he sets up an equally bulky cabinet which combines the projector with the screen. The heart of the new TV set is a colour cathode ray tube. With a diagonal of 33 cm, this is about the size of the tube in a conventional portable TV. But the tube operates at a very high power to produce an extremely bright miniature picture.

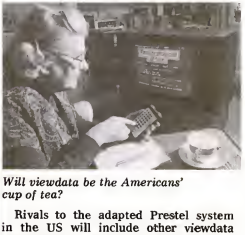
A wide aperture lens focuses the tube picture via two mirrors onto the rear of a milky-white screen, which is backed by a flat Fresnel lens the same size as the screen. This produces a giant picture, projected towards the viewer, which is surprisingly bright.

The set also includes what is called vertical interval reference (VIR) circuitry which improves colour control. American TV stations originally devised VIR circuitry to control the colour balance in TV signals between studios and transmitters. Reference information is squeezed onto one line of the picture (by a process similar to the teletext coding used by the BBC and IBA for their Ceefax and Oracle services). This coded information automatically adjusts the colour content of the picture while the set is receiving its signals. □

Prestel's rivals shape up in America

Louise Kehoe, San Francisco

A viewdata service in the United States, similar to the one which operates in Britain, will face heavy competition from other computerised information retrieval systems when it starts later this year. GTE, a big American electronics company, has purchased the right to use technology from Prestel, the British Post Office's viewdata system, in a trial service for business users. Viewdata—sometimes called videotex—is the generic name for equipment that calls up information from a computer onto a TV screen via the telephone network.



Will viewdata be the Americans' cup of tea?

Rivals to the adapted Prestel system in the US will include other viewdata services, operated either by government organisations or private companies. But probably the most powerful competition will be from broadcast teletext services. There is plenty of interest in the US in teletext, in which computerised information is transmitted to TV sets not by telephone but by radio waves. The BBC and the Independent Broadcasting Authority operate two teletext systems in Britain called Ceefax and Oracle.

The date for the start of GTE's first viewdata trial has not yet been fixed. It is believed to depend on how soon computer hardware for the system can be obtained. According to GTE, a number of publishing and newspaper companies are interested in providing information for distribution through the service.

The trial, which will probably involve less than a thousand receivers in offices, will be followed by another test service for residential users. GTE then expects to start a full viewdata service for both markets.

Insac, the British computer software company which sold the system to GTE, had to rewrite the original Prestel computer instructions, the software, before it could be used by the Americans. The first problem was that Prestel's software is designed to run on British GEC computers. Engineers had to adapt the software to run on DEC computers. Another task was to alter Prestel to work with the US's different TV transmission system. As a result of these changes, the US version of Prestel will have fewer characters per line in its text display than in Britain.

According to some observers, the British viewdata system compares poorly on technical grounds with others being proposed by the Canadian, Japanese and French telecommunications administrations. The Canadian system, called Telidon, looks specially promising because it allows users to draw good-quality graphics on the screen (*New Scientist*, 14 June, p 916). But Prestel technology is well tried, even if it isn't technically as good as other systems, and it seems this is what persuaded GTE to buy it.

Although GTE has an exclusive licence for Prestel in the US, it will not be the only US operator of an American viewdata information service. The US Departments of Agriculture and Commerce are sponsoring a 16-month trial project called Green Thumb. This is a viewdata service supplying data to farmers about weather and commodity prices.

The Green Thumb project will cover two counties in Kentucky. Western Union will supply the computer which will link users to the Department of Agriculture's information network. A second company, Motorola, will supply the essential "decoder" units—called Green Thumb boxes. (A decoder, which connects a TV set to the telephone system, consists of a small key pad containing a microprocessor and computer memory.) There will be at least one more viewdata service in the US. Knight-Ridder Newspapers Inc is to spend $1·3 million on a trial in the Miami area next year.

Among the broadcast teletext services already operating in the US is one which KSL TV has run in Salt Lake City for the past year. The company has designed its own transmission equipment and software, and has adopted the characters and graphics code of the UK's Oracle and Ceefax systems. KSL TV now wants to start a new version of its system. This will combine telephone transmission of signals with broadcast data. In the new service, called Touch-Tone teletext, the user will call up the computer by telephone, and "key in" the page number for the information he requires. The teletext page will then be broadcast to the person's TV receiver. This system is designed to combine teletext's ability to transmit data quickly to a large audience with viewdata's larger data base and two-way access.

Micro TV Inc of Philadelphia has designed a second US teletext system called Infotext. In this the decoder is separate from the TV, unlike the decoders in most teletext and viewdata systems (for instance those in the UK) which are fitted inside specially modified TV sets. The arrangement provides a simple package which can be sold to anyone who owns a television.

CBS, one of the major TV networks in the US, runs two more teletext services. However, these are systems "imported" from Europe. The company operates both the French Antiope system and the British Ceefax system from one of its TV stations in St Louis.

Cable television companies are interested in computerised information retrieval because they already have a large number of customers to whom they "pipe" TV programmes along cables. The companies therefore have a good chance of gathering extra income by offering information retrieval services as an "extra" to TV programmes. One example of such a service has come from Oak Industries of Crystal Lake, Illinois, which plans to offer its system to cable TV companies and broadcasters. □

Discussions start on information standards

A battle over teletext standards has just started in the US. American teletext services exist only on a test basis. Before full services can begin the US Federal Communications Commission (FCC)—the government body that regulates broadcasting in the US—has to agree on rules to ensure the compatibility of different systems. It will be two years before a decision is reached.

The FCC is considering proposals for teletext standards based on those from the telecommunications authorities in Britain, France and Canada. However, observers suggest that a new American set of standards will finally emerge, which borrow features from these three countries. The standards will probably cover three main areas.

First, transmission standards must be decided. These cover, for instance, the speed at which the binary digits that comprise computers' language are transmitted from the computer to the receiver. Next come format standards. These include the number of rows of characters displayed on the TV screen, and the number of characters in each row. Format standards also cover the "character set" defining how the letters and numbers on the screen are presented. Here the French and British standards differ, and this is sure to be an area of considerable debate.

The British services have 24 rows and 40 characters, while the French system has an extra row of text. By contrast, the character set in the US's KSL TV teletext service—a modification of the British system—has 20 rows of 32 characters. The French says that a modification of their system could provide more rows and characters per page, thus increasing the amount of information available.

The third type of standards covers the arrangement of sentences and words. These standards include, for instance, "boxing" and "flashing" on and off of characters. These devices are needed to draw certain sentences on the screen to viewers' attention. □

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Technology
continued

Boom ahead for powerful micros

Are the latest microprocessors, called "16-bit" devices, too powerful for the range of uses which people can dream up for them? Some computer industry observers have argued that this is so. But their view has been firmly refuted by predictions for a tremendous boom over the next five years in this new, powerful "family" of chips.

Microprocessors are defined in terms of their "word length", which is the number of binary digits (bits) in the blocks of data that comprise a computer's language. The greater the word length, the more complex is the computer, and the greater number of functions it can perform. The earliest microprocessors handled their data in lengths of four bits. Today's standard microprocessors in industrial processes work in 8-bit data lengths. Even more powerful are the devices just becoming available which have 16-bit words.

According to a report from a market research company, Creative Strategies International of San Jose, California (*The Microprocessor Industry*, £895) computer users will buy 16 million of the new 16-bit microprocessors in 1983. This is a quarter of the projected volume for the simpler 8-bit micros. But the growth represents a huge upsurge in sales from the 400 000 16-bit units sold last year.

Where the 16-bit micros will come into their own, according to CSI, will be in business systems, electronic data processing, medical instrumentation, telecommunications, industrial control, and numerical control machines in manufacturing processes.

Most microprocessors today are 4-bit devices which control fairly simple devices such as cash registers, washing machines and television tuners. The 8-bit microprocessors, such as the Intel 8080, are used in more complicated processes, for instance in industry. They are already worth much more to the manufacturers than the 4-bit microprocessors in terms of sales.

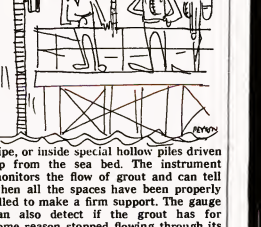
Last year, CSI estimates some 10 million 8-bit devices were sold, compared with 12 million 4-bit devices. But the former were sold for $62 million while the 4-bit microprocessors produced $25 million. □

Sea bed support

The construction group Wimpey is developing a technique which ensures that gas and oil rigs are safely anchored in their positions on the sea bed. The method was invented by Gordon Evans of the nuclear physics division at the UK Atomic Energy Authority, Harwell. Evans's team is now training Wimpey's engineers to use the method to build rigs around the world.

A radioactive isotope of scandium is mixed into the cement mix, called grout, which is poured into the spaces at the bottom of piles to hold them firmly on the sea floor. Normally the grout is pumped through pipes into these spaces in rather a hit-and-miss fashion. Divers have to be stationed at appropriate points to spot whether the grout has filled up all the cracks.

With the new technique, a radiation gauge is fitted to the outside of the grout



pipe, or inside special hollow piles driven up from the sea bed. The instrument monitors the flow of grout and can tell when all the spaces have been properly filled to make a firm support. The gauge can also detect if the grout has for some reason stopped flowing through its pipe. This can happen if it meets a sandy layer or other obstruction. □

British firms say no to video

There is still no sign of a British firm prepared to rival Japanese companies in making video recorders. The Thorn electrical group, which sells TV and video systems under the trade name Ferguson, now says that, despite early promises, it has no plans for manufacturing video equipment in the UK. A year ago, Thorn stopped selling the Philips video machine and agreed with JVC in Japan to market its VHS video system. Thorn has an option to manufacture VHS equipment in the UK. But so far the company has imported the goods from JVC and labelled them with Thorn brand names. In 1978 more than 60 000 video recorders were sold in the UK, of which half were VHS, and sales this year are likely to be well over 100 000.

The new range of VHS machines simultaneously launched by JVC and Thorn includes a portable colour recording system which Thorn says heralds the "arrival of electronic photography". The system will enable someone to make an hour's colour video movie on £5 worth of tape. This compares with around £100 for an hour of home cine-filming. However the battery-powered recorder, colour camera and battery charger will cost more than £1500. Moreover the system weighs around 15 kilograms. □

Patents review

Slow recovery for patent system

The British patent system is still recovering from the upheaval last June when the new UK and European patent laws, and the worldwide Patent Cooperation Treaty, came into effect. "It will be some years before the patent system running in the UK can be regarded as operating stably," says the comptroller of the British Patent Office in his 96th annual report (HMSO, £1·25). He says that, due to the changes, comparisons between statistics for the British Patent Office during 1978 and preceding years are "meaningless", and that predictions about patents are "unreliable".

But recent trends in inventions still stand out through the legal haze. There have been many new ideas for preventing static electricity in carpets made from synthetic fibres: static is an increasing irritation for anyone in the dry atmosphere of a centrally-heated building. Inventors have also done plenty of work on drugs such as peptides, which have morphine-like properties but are thought to be non-addictive, and on renal dialysis units for kidney patients.

Clearly aerosol propellants are "out" and replacements that work by pump action are "in". The latter do not involve any potentially harmful gases. And if patent filings are to be believed, natural asbestos will soon be replaced by aluminium oxide alternatives.

Two interesting points are buried in the report's small print. The comptroller acknowledges what has long been feared, that as the European patent schemes get under way the work of the British office will decrease. This will inevitably result in staff cuts. The comptroller also says that the legal changes have produced some bureaucratic errors—but the Patent Office says it will try to ensure that no inventor loses out because of an official mistake. □

Colourful safeguard

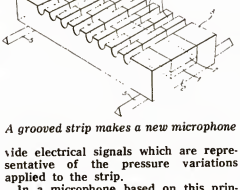
Bombers should beware: the UK's Secretary of State for Defence has patented (BP 1 542 411) a simple way of letting police analyse suspicious substances without taking them to a forensic laboratory. The patent explains that bombs are often made from a fuel such as diesel oil, and an oxidising agent such as ammonium nitrate or sodium chlorate derived from fertiliser. The method of detecting the bombs relies on a simple colour change.

A small sample of the suspected bomb mix is loaded into a tiny screw-cap container. The container is then inserted into a small tube like a hypodermic syringe. A fragile ampoule containing diphenylamine in phosphoric acid is pushed into the tube, and a plunger pushed home to crush the ampoule. The solution leaks through a small bore into the sample: if the tube turns a deep blue within 30 seconds, the material under test is almost certainly an explosive and should be treated with caution. □

Grooving to sound waves

The British telephone company STC has patented an interesting idea for optical strain gauges which pave the way for a super-accurate microphone. BP 1 536 340 describes a small strip of transparent material, such as soda-glass, with grooves cut across its top surface. A smaller piece of transparent material of different refractive index is inlaid into this substrate, through the processes of ion exchange and diffusion.

The combined strip is supported on point bearings so that it can flex under even the tinest applied pressure. As the substrate flexes, a stress pattern is created in the region under the surface grooves and in the inlaid material. This produces optical effects at the interface between the substrate and the "foreign" material. The optical effects modulate the beam from a laser. The modulations provide electrical signals which are representative of the pressure variations applied to the strip.

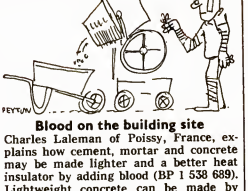


A grooved strip makes a new microphone

In a microphone based on this principle, the light from a laser is guided along optic fibres and through the strip. Sound waves impinging on the strip flex it and modulate the beam. Demodulation provides an electrical analogue of the sound signal. The analogue is similar to that obtained from a conventional microphone. But the method is more accurate because of the small size and low mass of the strip. □

Shooting satellites

Patent application BP 2 002 307 discloses details of work by the British Aircraft Corporation on launching satellites with a space shuttle vehicle similar to the one NASA is building in the US. The satellite is mounted on a reusable ejector system which spins the payload while blasting it away from the shuttle under gas pressure. The satellite is clamped on a shaft spun by an electric motor. The shaft is encircled by a high-pressure gas chamber shaped like a doughnut. An operator can then let gas escape to drive a piston with a bevelled front end. This releases clamps which normally hold the satellite on the shaft. At the same time the gas shoots the spinning satellite off into its correct orbit around the Earth. □



Blood on the building site

Charles Laleman of Poissy, France, explains how cement, mortar and concrete may be made lighter and a better heat insulator by adding blood (BP 1 538 689). Lightweight concrete can be made by injecting into it foam, air or colloids. The inventor argues that the easiest way is to inject air by adding red blood corpuscles: the haemoglobin which they contain drags air along with it.

The blood can be in its normal liquid form, or it can be a freeze-dried powder. It is essential to stir the blood and concrete mixture, ideally with a rotary mixer working at high speed, so that as much air as possible enters the concrete mix. Laleman says that low-density concrete deforms more easily than conventional concrete and so does not crack. □

Teaching session on patents

The Confederation of British Industry has organised a one-day conference next Wednesday to assess the new European patent system. The fee for the conference, at CBI headquarters in London, is £80 plus VAT. Among those contributing will be representatives from the British and European patent offices and spokesmen from Bayer AG and IBM, companies big enough to afford the cost of filing strings of foreign patents. British patent agents will also discuss their experiences. □

Heads up for stereo

The BBC has broadcast several radio programmes with the "dummy head", or binaural, stereo-sound system. According to this age-old idea, the sound is picked up by a pair of tiny microphones set in the "ears" of an imitation human head. The sound is reproduced with hi-fi stereo headphones to give a realistic surround-sound effect. There is controversy, however, over the extent to which the dummy head should replicate a real head. The BBC has already abandoned the traditional approach of accurate replication and instead uses a disc of plastic material instead of a real head. Now Sony has patented yet another idea.

In BP 1 535 289, Sony claims that results as good as those obtained from implanting microphones in a human head follow from using a conical dummy head, with rubber flaps as ears. Two miniature microphones are mounted alongside the "ear" flaps and the narrow end of the cone is pointed at the sound to be recorded. The cone can be made like a balloon to permit easy packing: it is inflated only just before use. □

Adrian Hope

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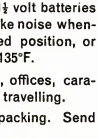

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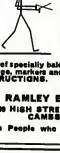

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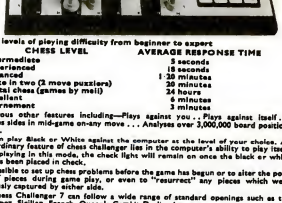

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Molecules in a spin

Nuclear magnetic resonance spectroscopy is now a standard technique for chemists in their analysis of complex compounds

Robert Lenk
is in the Department of Chemistry at the University of Surrey, Guildford

In recent years chemists have developed an impressive array of sophisticated techniques, with which they investigate vast numbers of chemical compounds. Their chief weapons comprise a variety of spectroscopic methods: one of the most important, particularly for organic chemists, is that of *nuclear magnetic resonance* (NMR) spectroscopy. NMR spectra, especially from protons and carbon-13, can reveal a great deal about chemical compounds. Chemists use the spectra to identify important groups of atoms within complex molecules—these are the so-called *functional groups*, such as −OH, −COOH, −CO etc. The chemists can then piece these groups together one by one, as in a jigsaw, using supplementary clues from the spectra, and so determine the structure of unknown compounds.

The technique of NMR depends crucially on the magnetic properties of atomic nuclei within the compounds. One fundamental property of the nuclei is that of "spin". Many nuclei have some intrinsic angular momentum as if they were each spinning about an axis—they have "spin"—and it is these nuclei that can be observed by NMR. A nucleus with spin behaves very much like a miniscule bar magnet, and when it spins in a magnetic field it experiences a twisting force, or torque. This force tends to align the nuclear "magnet" with the magnetic field, and causes the nucleus to precess—the spin axis itself rotates about the field direction (Figure 1)—similar to a top spinning in the Earth's gravitational field. The precessional frequency of the nuclear "spinning top" is called the *Larmor frequency*, and depends on both the spin of the nucleus and the strength of the magnetic field.

The precessional motion of the nucleus follows the shape of a cone and it turns out that the number of ways this cone lines up with the external magnetic field is limited, and depends on the value of the nuclear spin. For example, for the proton and the carbon-13 nucleus—each of which have spin of $^1/_2$ in the appropriate units—there are two possible alignments: the nuclei line up either with the external magnetic field or against it (Figure 1). The former state of alignment has less energy and is the more favourable; as a result nuclei prefer to be in this energy state.

But if nuclei in the state with lower energy are provided with just the right amount of energy they will flip into the higher energy configuration. This happens when the frequency of the applied energy is the same as the Larmor frequency of the nuclei under observation. The nuclei "resonate" as they absorb the energy—hence the term *nuclear magnetic resonance*. With the magnetic fields we can obtain today of 1 to 11·7 Tesla—the Earth's magnetic field is some 0·0001 Tesla—radio-frequency (RF) energy can induce the flip from one nuclear state to the other.

If the process were as simple as I have just described it would be useless to chemists, because all nuclei of the same type, irrespective of their positions within a molecule, would resonate at a single frequency and so give no information about the structure of the molecule. Fortunately, this is not the case, because of the effects of electrons surrounding the nucleus.

An electron circulating around a nucleus is equivalent to an electric current and produces a magnetic field opposing the applied field. As a result, the magnetic field a nucleus "sees" is modified by the surrounding electrons—they "shield" the nucleus from the external field. This shielding causes a shift of the resonant frequency from that of an unshielded nucleus of the same type. So nuclei in real molecules, being in different "electronic" environments, resonate at different frequencies. As the arrangement of electrons in a molecule determines its chemical properties, these "frequency shifts" are called *chemical shifts*. The carbon-13 NMR spectrum of acetone (Figure 2) clearly shows the distinct chemical shifts due to carbon atoms in two different environments within the molecule. Just over 1 per cent of carbon nuclei are carbon-13; the remainder, mainly carbon-12 plus a very small amount of the radioactive isotope carbon-14, do not possess spin and do not show up in NMR spectra. Chemical shifts are measured relative to those in a reference compound, usually added to the sample. For proton and carbon-13 resonances, tetramethylsilane ($Si(CH_3)_4$), abbreviated to TMS, is the recommended reference.

There exists further structure, or "fine" structure, in NMR spectra, originating from the interactions between magnetic nuclei. This phenomenon, known as *spin-spin splitting* arises because the magnetic field a nucleus experiences is influenced by the neighbouring nuclei. The

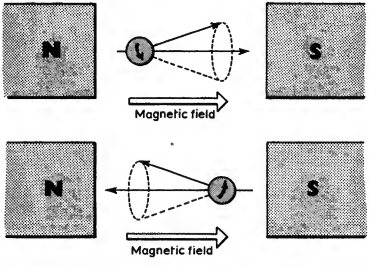
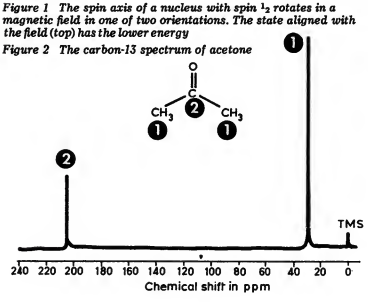


Figure 1 The spin axis of a nucleus with spin $^1/_2$ rotates in a magnetic field in one of two orientations. The state aligned with the field (top) has the lower energy

Figure 2 The carbon-13 spectrum of acetone



effect is to split the single resonance line into several, forming a multiplet. The separation of the multiplet lines is called the *coupling constant* and is independent of the strength of the applied magnetic field.

The amount of splitting in a multiplet depends on the number of chemically identical protons—ones with the same configurations of electrons as each other—that are close to the proton producing the multiplet. For example, one group of methyl protons in ethyl acetate (Figure 3) is next to *two* identical methylene protons and consequently shows up as a *triplet* in the NMR spectrum—the spacing between each member of the triplet being equal to the coupling constant. Similarly, the methylene protons being next to *three* methyl protons produce a *quartet*, with the same line separation. The single line in Figure 4 is due to the methyl group that has no neighbouring protons.

From what I have said so far, we can see than an NMR spectrum is a kind of "molecular fingerprint", and careful analysis of the spectrum of an unknown compound can provide detailed information of its molecular framework. But first a chemist must measure the spectrum and to do this he uses a nuclear magnetic resonance (NMR) spectrometer, which consists of a magnet, a radio-frequency (RF) source and a detector.

The sample, usually liquid or gas—solids require special instrumentation—sits in a tube between the poles of the magnet. Spinning the tube makes the magnetic field seen by the sample appear more homogeneous than otherwise. In fact, for high resolution spectra—that is with sharp, clean spectral lines as opposed to wide, fuzzy ones—both the RF source and the magnetic field must be as homogeneous as possible, at least to one part in a thousand million (10^9). This is because the NMR signals are weak—at room temperature there is an excess of only 1 in 100 000 nuclei in the lower energy level, and it is only these nuclei that can make the transition to the higher level.

Permanent magnets or electromagnets used in NMR spectrometers give fields up to 2·3 Tesla, and for proton resonance studies, spectrometers operating at resonance frequencies up to 100 MHz are commercially available. More powerful superconducting electromagnets can go up to 11·8 Tesla and provide greater resolution; the corresponding proton resonance frequency is 500 MHz.

In the so-called *continuous wave* spectrometers, either the frequency or, in older instruments, the magnetic field, is varied to search for the resonant spikes. There are many ways of detecting the resonance frequency; in one method a drop in the RF power, corresponding to absorption by

Tritium nuclear magnetic resonance spectroscopy

Over the past 11 years, members of the chemistry department at the University of Surrey have collaborated with the Radiochemical Centre at Amersham in developing the technique of *tritium* NMR spectroscopy. Tritium, a radioactive isotope of hydrogen, has found widespread use in medicine and in industry as a radioactive "label". Labelling involves attaching tritium atoms to a chemical compound or replacing some atoms by tritium atoms. The radioactive emissions of the tritium then reveal the location of the labelled compound on its way through a human body, for example.

In many cases it is important to know which site the tritium label occupies within a chemical compound. This can be discovered by chemical degradation —a process which breaks up the compound to reveal the labelling pattern. But this technique is time consuming and not always unambiguous; many side reactions can occur during the analysis. Tritium NMR spectroscopy, on the other hand, is non-destructive and reveals the labelled molecular sites immediately. Furthermore, tritium is the most sensitive nucleus available for NMR studies, which means that very small amounts can be detected. This is important for safety, as tritium is radio-active.

Tritium resonance frequencies are very close to the corresponding proton frequencies—the tritium Larmor frequency is 1·06663974 times that of the proton. Thus the wealth of knowledge of proton chemical shifts can be applied directly to tritium spectra—comparing proton and tritium spectra for the same chemical shows which sites the tritium atoms have attached themselves to. Moreover, the relative intensity of the tritium spikes in the spectra show the way in which the tritium is distributed. The drug vinblastine provides a good example of the use of NMR to locate tritium labels. This drug, which is used in cancer therapy, is unstable and so cannot survive in vigorous experimental conditions. Its tritium NMR spectrum compared against a proton spectrum shows that the tritium takes the place of the hydrogen at certain locations within benzene rings in the compound. Figure *A* below shows that 44 per cent of the tritium takes up the so-called 17-position, 46 per cent the 12′- and 13′-positions and the remaining 10 per cent is distributed between the 11′- and 14′-positions. The molecular complexity, difficult chemistry and very high cost vinblastine would have made it almost impossible to determine this labelling pattern quantitatively by conventional chemical means.

But a certain degree of unintentional, or *non-specific*, labelling can occur during the labelling process. Figure *B* shows the spectrum of a sample of folic acid, tritiated in a process in which the tritium replaces bromine atoms within the acid. The spectrum reveals that the acid takes up tritium not only at the desired 3′- and 5′-positions, but that appreciable amounts, 25·5 per cent and 32 per cent respectively, go to the 7- and 9-positions.

Although tritium NMR spectroscopy is primarily used to establish labelling patterns, it has many other uses. These include the determination of the so-called *geminal* coupling constants—the coupling between protons around the same carbon atom, as in the group CH_2, for example; the elucidation of complicated proton spectra in which neighbouring multiplets overlap; the unravelling of mechanisms for biosynthesis and studies of catalysis. Tritium is particularly useful in these studies because exchanging it for hydrogen does not change the chemical properties of a compound. □

Figure A Tritium NMR (upper curve, right) and proton NMR of the drug vinblastine. Its chemical structure is shown below

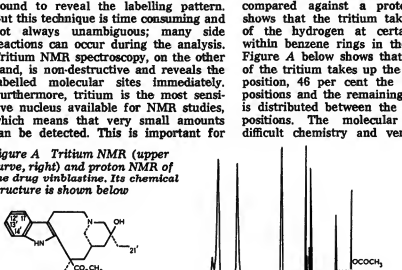
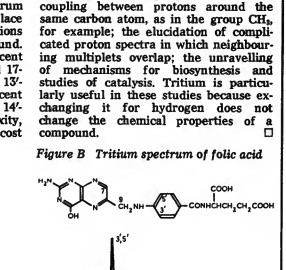


Figure B Tritium spectrum of folic acid



resonating nuclei, is sensed by a bridging circuit, similar to a Wheatstone bridge. The resulting signal in the bridge is then amplified and displayed on a chart recorder.

Under proper operating conditions nuclei of the same type absorb the same amount of energy and so the relative strengths of the NMR signals reflect the number of nuclei producing them. Integration equipment that determines the area under each peak or multiplet is therefore a standard fitment on all NMR spectrometers. Integration of the proton NMR spectrum of ethyl acetate (Figure 3) shows that the singlet and the triplet are each due to three protons, while two protons give rise to the quartet.

As I mentioned earlier, sensitivity can be a problem in NMR experiments, but the development of *Fourier transform* (FT) spectrometers has largely overcome this. Fourier transform spectrometers differ from more traditional instruments in that they observe the decays of excited nuclei as they return to the lower energy state after being energised by a radio-frequency pulse. This process, known as *relaxation*, is relatively slow, so the time the nuclei spend in the higher energy spin state is relatively long—for protons it is a few seconds. As the higher spin energy dissipates it gives rise to a signal which is detected by a receiver. This signal, the *free induction decay* (FID) contains all the information about intensity, line shape, chemical shift and splitting of the spectrum. The signal from protons in ethyl acetate is shown in Figure 4. The mathematical process of Fourier transformation converts this signal into the more familiar spectrum (Figure 3).

In between the RF pulses, each of which irradiates all the frequencies in a spectrum equally and simultaneously, the receiver is switched on to detect the decay signal from the excited nuclei. A number of decay signals are acquired,

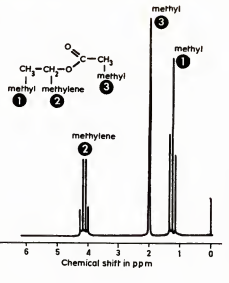


Figure 3 The proton NMR spectrum of ethyl acetate illustrates the line splitting that occurs when a nucleus is influenced by identical neighbouring nuclei

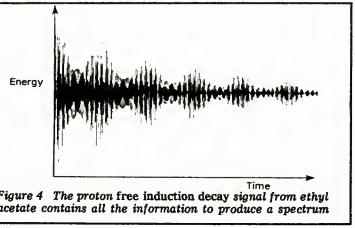


Figure 4 The proton free induction decay *signal from ethyl acetate contains all the information to produce a spectrum*

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added together and stored in digital form by a computer. The sensitivity depends on the total number of FIDs accumulated. In this way random background "noise" is cancelled out while weak signals, originally indistinguishable from noise, are amplified.

It is, perhaps, a fortunate twist of nature, at least for organic chemists, that the most common isotopes of carbon and oxygen, carbon-12 and oxygen-16, do not have a nuclear spin. If they did, the task of interpreting proton spectra would be almost impossible for all but the simplest molecules because of the endless variety of possible interactions between different types of nuclei. Carbon-13, which does have spin, is present at a 1 per cent level only, and therefore does not interfere significantly with a proton spectrum. But a carbon-13 spectrum can be complicated by proton interactions and in many cases this proton interference must be removed.

This can be done by irradiating the sample at proton frequencies at the same time that the carbon-13 spectrum is obtained. This induces a very rapid transition between the upper and lower proton energy levels, so that the carbon-13 nucleus "sees" only an average orientation of the proton magnetic moments. When this occurs, spin-spin coupling between the different types of nuclei is lost and a single line appears for the carbon-13 resonance. Coupling between carbon-13 nuclei is not normally a problem, so each carbon atom in a molecule gives rise to a single line in the carbon-13 spectrum (Figure 2).

I have given only a brief idea of how chemists use NMR spectroscopy to analyse chemical compounds. The technique has many other applications, such as in tritium NMR (see Box). There is no doubt that future developments will open even more areas of research, and that chemists will be well equipped to tackle any new problems. □

The man who invented black holes

His work emerges out of the dark after two centuries

Dr Gary Gibbons
is with the Department of Applied Mathematics and Theoretical Physics at the University of Cambridge

Black holes are at present enjoying a certain vogue in astrophysics; scarcely a week passes in which they are not invoked to account for some set of astronomical observations. The basic definition of a black hole is that it is a region of space towards which the gravitational attraction is so great that not even light can escape. This idea is not a difficult one, at least superficially, although it does lead into various conceptual difficulties which can only be resolved properly by applying Einstein's theory of general relativity (*New Scientist*, vol 81, p 756).

The idea that if the escape velocity of a body (the velocity a projectile needs to overcome the body's gravitational attraction) exceeds the velocity of light then the body will be effectively invisible or "black" is so simple that it prompts the question as to who first thought of it. Until recently I had believed, in common with most scientists studying gravity, that the answer to this was Pierre Laplace, the celebrated French mathematical astronomer. In the first and second editions of his book *Exposition du Systeme du Monde* published in 1796 and 1799, he stated that a body whose diameter exceeds 250 times that of the Sun and with the same density as that of the Earth would appear invisible. In 1799 he published a proof of the result in a German astronomical journal—a translation of which is included in the advanced textbook on general relativity by George Ellis and Stephen Hawking. However, it now appears that Laplace was preceded by some 13 years by a much less well known English physicist—John Michell. This fact has recently been pointed out by Stanley Jaki in a footnote in an article on another early work on light and gravitation, by Johanne von Soldner, which is published in the current edition of *Foundations of Physics*.

Royal Society paper

Michell's prediction of the existence of what we call black holes was made in a paper read before the Royal Society on 27 November, 1783, and which is to be found in the *Philosophical Transactions of the Royal Society*, vol 74, p 35, published in 1784. Michell's paper is quite a considerable one—much larger and more detailed than that of Laplace. He was not primarily concerned with black holes, but with the problem of determining the sizes of stars, as is indicated by its characteristically lengthy 18th century title: "On the Means of Discovering the Distance, Magnitude etc of the Fixed Stars, in Consequence of the Diminution of the Velocity of the Light, in Case of such a Diminution should be found to take place in any one of them, and such other Data should be procured from Observations, as would be further Necessary for that Purpose."

Michell starts his paper by deducing the amount that the gravity of a star would slow down the journey of an ordinary particle from the surface of a star to Earth, assuming the usual laws of Newtonian mechanics. He then says, "Let us now suppose the particles of light to be attracted in the same manner as all other bodies with which we are acquainted; that is, by forces bearing the same proportion to their *vis inertiae* (or mass), of which there can be no reasonable doubt, gravitation being, as far as we know, or having any reason to believe, an universal law of nature." From this assumption he deduced ". . . if the semi-diameter of a sphere of the same density with the Sun were to exceed that of the Sun in the proportion of 500 to 1, a body falling from an infinite height towards it, would have acquired at its surface greater velocity than that of light, and consequently supposing light to be attracted by the same force in proportion to its *vis inertiae*, with other bodies, all light emitted from such a body would be made to return towards it by its own proper gravity".

He goes on to argue that less massive bodies would merely produce light moving more slowly than usual, and to design an ingenious prism experiment for comparing the velocities of light from two separate stars which form part of a binary system revolving about each other. Later he says "If there should really exist in nature any bodies whose density is not less than that of the Sun, and whose diameters are more than 500 times the diameter of the Sun, since their light could not arrive at us; or if there should exist any other bodies of a somewhat smaller size which are not naturally luminous; of the existence of bodies under either of these circumstances, we could have no information from sight; yet, if any luminous bodies infer their existence of the central ones with some degree of probability, as this might afford a clue to some of the apparent irregularities of the revolving bodies, which would not be easily explicable on any other hypothesis; but as the consequences of such a supposition are very obvious, I shall not prosecute them any further".

From these quotations it is clear that Michell in 1783 understood many of the basic principles of black hole physics which are in daily use almost 200 years later. In some respects he is in error. We now know that the prism experiment he proposed and which was actually carried out by the astronomer Nevil Maskelyne was doomed to failure. Einstein's theory is built on the assumption that light from all sources has the same velocity when it reaches us. The reason that it can be "slowed down" is because of the distortion which gravity produces in space and time. We also know that light has many wavelike properties which cannot be accounted for by the Newtonian particle theory that Michell used. Indeed, the probable reason that Michell's speculations were largely forgotten in the 19th century was that the Newtonian particle theory of light was completely overthrown by the wave theory of Thomas Young (1801), and not until the development of quantum theory did the concept of a particle of light, or photon, become scientifically respectable again.

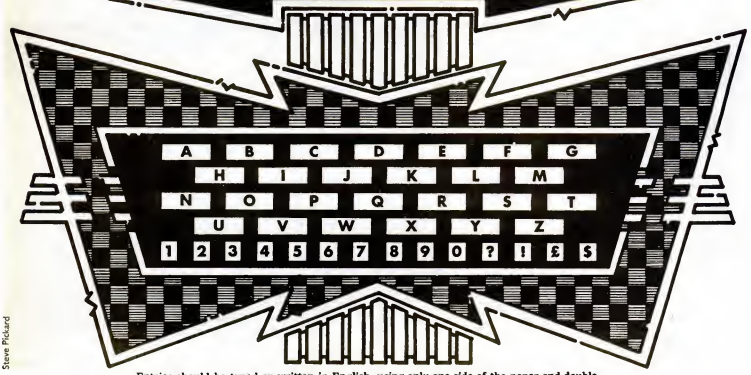
Michell himself made other important contributions to physics; he was the first person to enunciate clearly the inverse square law for magnetic forces, and it was he and not Henry Cavendish who first suggested what is now inaccurately referred to as the "Cavendish experiment". In this experiment the tiny force of gravitational attraction between two lead balls is measured using a delicate "torsion balance". Michell attempted the measurement himself but ill health and his death prevented a successful conclusion. Later, Cavendish was able to achieve what had eluded Michell, and in his classic paper on the subject he properly acknowledges Michell, a personal friend.

Michell was highly regarded in his own day but since then his reputation has fallen. His work illustrates the power of simple physical reasoning to elucidate the essential features of a highly complicated subject and to extract from it important predictions. These qualities are as important today as they were 200 years ago. In my view he deserves more credit than he has so far been given. □

Why be a SCIENTIST?

This is the theme of an essay competition sponsored by *New Scientist* and British Association Young Scientists, which is open to anyone aged between 13 and 18 on 1 September, 1979. The winning essay (the judges will take entrants' ages into account) and full results will be published in *New Scientist* on 6 September. The winner will receive £20 and there are two 2nd prizes of £10. All three will be offered bursaries to attend, free of charge, the 141st annual meeting of the BA at the Heriot-Watt University, Edinburgh, 3-7 September. All prize winners and 10 runners-up will be given a free subscription for one year to *New Scientist*.

Geologists are employed by Allied Breweries (UK), biologists by the General Electric Company, physicists by Arrow Life Assurance, and psychologists in the Aircraft Group of British Aerospace. Indeed a science background is now viewed by most employers as part of an individual's general education—just as traditionally history and the classics were in the past. That scientists have to be painstaking, accurate, observant and critical stands them in good stead for many jobs. But do scientists have sufficient say in politics and the way that society is advancing? And do the rewards they get match their efforts?



Steve Pickard

Entries should be typed or written in English, using only one side of the paper and double line spacing. On the top left hand corner of the first page give your full name and address and date of birth. Put your name on every sheet. The competition closes on 20 July. The judges will include Dr Bernard Dixon, editor of *New Scientist*, and Alec Hughes of BAYS. Post your entry to Pat O'Flanagan, Rm 2637, King's Reach Tower, Stamford St, London SE1

Feedback

Trouble at th' laboratory

Britain's government scientists were on the march last Friday—for the first time ever, civil service scientists marched through London in a pay protest. And when their union, the Institution of Professional Civil Servants, called a one-day strike last Friday, it could not have guessed that the stoppage would have international repercussions. Yet it did—two technicians employed at the Rutherford Laboratory in Oxfordshire failed to turn up at the European Organisation for Nuclear Research (CERN) in Geneva.

Back in London, 2000 scientists and technologists marched from the British Museum (where IPCS scientists work on dating and preserving the exhibits) to Regents Park. There coaches picked them up and whisked them away to the Wembley Conference Centre, where they were joined in a rally by 2000 colleagues from all over the country.

The most obvious impact of the dispute was the "havoc" created at Glasgow and London's Heathrow airports by striking air traffic controllers (who joined the strike in solidarity and are not themselves directly involved in the dispute). But quietly and without fuss, thousands of scientists normally beavering away in seclusion downed microscopes, test tubes, and oscilloscopes. Forensic scientists, chemists who analyse food and water, physicists who police metrication, geophysicists, weather forecasters—every manner of scientist came out. The IPCS claimed an almost total response to its strike call.

But there were pockets where the response was not so solid. At the Royal Greenwich Observatory only about half the scientists stayed away. But the RGO has never had a strike in its history, so even a 50 per cent turnout is pretty revolutionary. At the Rutherford Laboratory there was even an Arthur Scargill-type picket—for 1½ hours.

At the Laboratory of the Government Chemist, strikers maintained a picket all day. The militant IPCS branch there—battle-hardened in its campaign to stop the laboratory moving to Cumbria—had 280 out of 300 members on strike. Some even joined the union specifically to strike.

Clearly, IPCS members are angrier than they have ever been. But in some places, there is confusion about the ins and outs of the dispute (hardly surprising in view of the labyrinthine meanderings of civil service pay structures). There were complaints at the Culham fusion laboratory, for example, that IPCS had not kept its members fully informed. There are mumblings too in the Civil Service Department (the other side in the dispute) that "line managers"—the bosses of laboratories—have not put the management's view forcefully enough.

Despite these moans, it is abundantly clear that government scientists are on the move. If the IPCS can maintain the momentum, the government should begin to worry. □

Vanishing act

Fascinating what calculators can do. Four brave experimenters from Llandaff High School recently wrote to us telling amazing tales of their Casio 2200s. Apparently, during "a particularly boring and uninteresting physics lecture" the famous four started fondling their Casios.

Much to their surprise, they found that if they pressed a magic sequence of buttons, the display disappeared altogether and could only be persuaded to put in further appearances by switching the machine off and starting again. They say that the magic sequence is: (function), (function), mode, mode, mode, a.b/c, −, 1, and =. □

Colour supplement

In the land of free enterprise and initiative, the banks must secretly wish that Xerox had never developed a full colour copier. Their problem isn't so straightforward as spotting the odd full colour copy of a cheque or banknote. No one in their right mind would hope to con a bank teller that way. The real risk comes when old bank notes are burned. For the bank employee who hit on the idea, it must have seemed the perfect plan. Run off some colour copies of a hundred dollar bill, scrumple and dirty them up, sandwich them between a couple of genuine old bills due for the furnace. Like most perfect crimes it went wrong. But another few minutes and all the evidence would have disappeared in a puff of smoke leaving the bank teller a richer man. □

All the news

We at *New Scientist* are rather glad none of us travelled to New York recently to report on one of the world's biggest computer shows. For the usually reliable magazine *Computing* reports that; "Nothing really new was announced at this year's National Computer Conference". Shades of small earthquakes in Bolivia. □

Rip off

We've heard nothing whatsoever from the British Phonographic Industry following our Comment (17 May, p 522) which suggested that the BPI is wasting its members' money on the hopeless pursuit of a "spoiler signal". The BPI's dream, you will doubtless recall, is an inaudible signal which in some unspecified black magic manner prevents the public from taping gramophone records without official permission. Our point was echoed by a national newspaper and the BPI has now taken the extraordinary step of replying to the criticism with a statement published in a music biz weekly. International research is continuing and has proved that spoilers are a possibility, says BPI boss John Deacon, and there is no question of us abandoning the search. Impressive words. But why has the BPI spoken only to a non-technical music paper: how about trying them on *New Scientist* readers? □

Canterbury College of Art

Mr and Mrs Lung, destroyed by cigarette smoke. A hint of ads to come?

Canterbury tales

In the year that a cigarette advertisement won an award for the best ad from the magazine *Campaign*, it is reassuring to find that tomorrow's advertising executives—or at least designers—are on the right side. For example, down at Canterbury College of Art, students (taught by one of *New Scientist's* own very wonderful art department) have come up with a plethora of advertising ideas aimed at stopping smokers continuing their filthy habits.

The characters in our photograph, Mr and Mrs Lung, work for Smokey Joe, and, according to one group of Canterbury students, have a hard time. They propose a campaign of television ads, posters, T-shirts and so on relating the trials and tribulations of the unhappily married Lungs—including one television ad that climaxes in a divorce as one Lung is surgically excised because of the disease that has wrecked it.

But by far the most stunning idea came from a group which reasoned that young children must be convinced that smokers are losers. Picture the scene they evolved for a television ad. Tracy, proud as punch, is swimming for her school in a local gala. Unfortunately she finishes last—and is cruelly shunned by her schoolfriends. Sloping off to escape the approbium, Tracy lights up a gasper—the cause and effect of her despairing failure. Why should the devil have got all the good ads? □

Old banger

The petrol shortage is crazing minds. One petrol station has had to turn away holiday customers asking for petrol to be pumped into open plastic buckets and watering cans. In the US, Amoco Oil recently felt it necessary to advise car owners that petrol "should not be stored near an appliance like a water heater, that has a pilot light." The National Safety Council then received a letter from a motorist asking for advice on the "best way to keep eight 55 gallon drums of petrol in my back yard". In a last ditch effort to save the public from themselves, the NSC has issued a public reminder that just one gallon of petrol has the explosive power of 14 sticks of dynamite. □

What are mast cells for?

At the root of allergies are the mast cells, but no one knows whether these cells confer any benefits. They can even be lethal. Evolution would surely not allow a totally deleterious system to survive

Dr Geoff Watts
is deputy editor of *World Medicine*

As anyone who suffers from asthma or hay fever will moistly and noisily agree, mast cells—the cells behind these debilitating afflictions—have the capacity to make a confounded nuisance of themselves. The source of this nuisance is the mast cell's most characteristic feature: the large number of granules scattered throughout its cytoplasm. Each granule contains a cocktail of chemical mediators that range from the obscure to the familiar, and number among them the vexatious histamine molecule. Mast cells can degranulate, falling apart and emptying the granules thereby unleashing these mediators jointly to foster the "wheezing, sneezing and itching" so familiar to all victims of allergic disease.

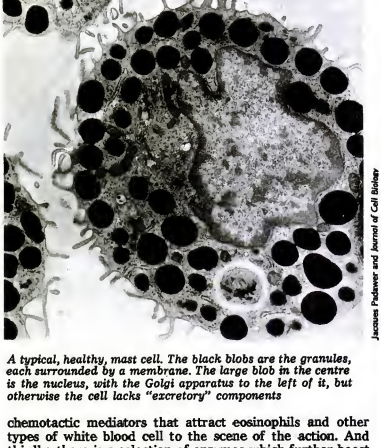
This sequence of events would be entirely unremarkable if the pollen, house dust, or whatever other allergen triggers the mast cells to empty their granules, posed a serious biological threat to the unfortunate sniffler. But usually it does not. The intrinsic nuisance value of allergens is far less than that of the misery of the response they precipitate—which seems, superficially at least, like a serious flouting of evolutionary rules: if allergic reactions are disadvantageous, why hasn't natural selection eliminated them? The escape from this paradox lies in postulating either a concealed purpose for the system, or one that has recently become redundant. Or, to put it another way, what are (or were) mast cells *really* for?

The question has prompted two ingenious answers; both are biologically plausible, though one is highly speculative. And the alternative *raisons d'être* they suggest for the mast cell are as different as they could be—for while one theory argues that the mast cell exists to discharge its granules, the other has it that degranulation marks the end of the mast cell's "normal" function. First, though, a word or two about the presumed mechanism by which a pollen grain can make you weep.

What happens in hay fever

Mast cells are heavily concentrated in the skin and in parts of the respiratory system, including the trachea, the bronchii and the nasal mucosae. According to conventional wisdom—the qualifying adjective is necessary because all immunological theory provokes dissent and allergy is no exception—the sequence of events in an immediate (type I) hypersensitivity reaction like hay fever starts with invasion of the body by foreign antigens: pollen grains, say. This stimulates the formation of antibodies belonging to immunoglobulin class E (IgE), and these rapidly attach themselves to the surface of mast cells. Nothing much then happens until more of the same antigens put in a further appearance. When they do, they attach specifically to adjacent pairs of surface-bound IgE molecules and act as a kind of bridge between them. For whatever reason—the precise mechanism is still debated—this bridging is a great event in the life of a mast cell; thus activated, the mast cell degranulates, and releases its chemical mediators to induce anything from local inflammation to the convulsions and even death—the so-called anaphylactic shock—which is the occasional consequence of insect venom, though almost never of the more benign pollen grain.

The mediators released from the mast cell fall into three broad categories. First, there are molecules like histamine and serotonin that engorge local blood vessels and cause fluid to leak through their walls, the two things that lead to inflammation and swelling. Secondly, there are so called chemotactic mediators that attract eosinophils and other types of white blood cell to the scene of the action. And thirdly, there is a selection of enzymes which further boost the inflammatory reaction and are presumed to start breaking up local tissues in preparation for any healing which may be required. The release of the preformed mediators from the mast cell granules also precipitates new synthesis of more chemical mediators which further contribute to the three processes. From start to finish, then, the full sequence of events in an immediate hypersensitivity reaction is exceedingly complex and something of a cascade, with activation of the mast cell as the triggering event. Which brings us back to the original question: why? What is the purpose of this biochemical mayhem?



Jacques Padawer and Journal of Cell Biology

A typical, healthy, mast cell. The black blobs are the granules, each surrounded by a membrane. The large blob in the centre is the nucleus, with the Golgi apparatus to the left of it, but otherwise the cell lacks "excretory" components

Only one explantion of immediate hypersensitivity has so far found anything approaching general acceptance; it is that the events are a side effect of one of the host organism's defences against attack by larger parasites, notably worms. Much of the evidence is still circumstantial—such as reports that individuals who carry an exceptionally heavy burden of parasites often possess higher than average levels of IgE antibody. But several recent studies, especially those of Barry Kay and his colleagues at Edinburgh University's Department of Pathology, have raised the theory to a new level of respectability.

Barry Kay has been working on the blood fluke, *Schistosoma mansoni*, a parasite that spends its adult life in the veins of the lower abdomen. Like many parasites, *S. mansoni* exploits an intermediate host to move itself from one human to another. A larval form of the parasite, the cercaria, leaves the intermediate host—a water snail—and swims free until it reaches its next human victim. It penetrates the skin, sheds its tail, and enters the next phase of its life history. The schistosomula that emerges

from this transformation sets off an immune reaction—including the creation of IgE antibodies which, as is their custom, attach themselves to the host's mast cells.

Any parasites that subsequently penetrate the host interact with these mast cells—which have been sensitised to the schistosoma by the IgE—and stimulate them to degranulate. This releases histamine and the rest of the chemical mediators, including ECF-A, the substance that attracts the eosinophil cells, which help destroy the invaders. Barry Kay's experiments suggest that ECF-A not only attracts more eosinophils to the site of the invasion, but also contributes to a kind of "arming" process that boosts their parasite-killing capacity. The full sequence of events as Kay sees it is more intricate than this, and almost certainly involves complement, the mysterious group of substances that enhance the effects of antibodies. But, for present purposes, suffice it to say that certain parasitic invasions mobilise the IgE/mast cell/eosinophil system, which attempts to counter the threat, and that the broad outline of what happens is remarkably similar to the events that are thought to be taking place in an immediate hypersensitivity reaction. Is hay fever, then, a misguided, futile attempt to beat off a non-existent flux of parasites?

The advantages of hay fever

The error—if such it is—seems surprisingly gross: we are accustomed to expect better than this of biological recognition. But on reflection the surprise diminishes; as Barry Kay points out, the very complexity of pollen grains and house dust mites predisposes them to possess, by chance, certain antigens similar or even identical to those of the parasites. And as long as parasitic worms are a threat to host survival—and in large numbers they certainly are—natural selection might well tolerate inappropriate allergic reactions which may be irritating but will only rarely be significantly damaging. Even Charles Darwin can be called in evidence for this viewpoint: "If a fair balance is struck between the good and the evil caused by each part, each will be found on the whole advantageous." Twentieth century industrialised man with his hygiene and his helminthicides has shifted the balance; the anti-parasitic role of mast cells and IgE is no longer so important, and all we are aware of is the nuisance value of the side effects—the allergies—that remain. But one can hardly blame evolution for failing to anticipate the major successes of biological research and public health engineering.

Barry Kay is by no means claiming that the theory is already 'proved. But, interestingly, he can cite a report from New Guinea—where hookworm infestation is endemic—that atopic individuals (people constitutionally predisposed to developing immediate hypersensitivity) shed fewer worm eggs than do their non-atopic counterparts. You might even say that allergy is the price a New Guinean has to pay for the anti-parasitic benefits of a more than averagely reactive immune system.

So much for the theory of a recently redundant purpose; on now to the theory of a concealed purpose—and the work of Jacques Padawer, professor of anatomy at Albert Einstein College of Medicine in New York.

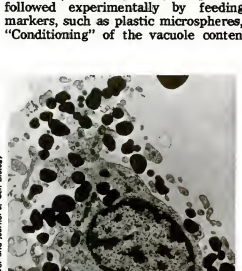
Padawer, like Barry Kay, has also noted the evolutionary paradox posed by the mast cell. But, unlike Kay, it is the rare, traumatic effects of degranulation that have set him speculating. Recalling the fatalities that have been known to follow the explosive degranulation of an atopic individual's pool of mast cells, Padawer remarks: "That a trivial event such as an insect bite might cause death is difficult to reconcile with concepts of evolution which hold that deleterious traits are normally eliminated via selection pressure . . . One must therefore postulate that mast cells are so useful to higher organisms as to warrant special tolerance." And that usefulness, according to Padawer, lies not in degranulation and mediator release—which he sees as events "antithetical to proper function"—but in what the mast cell is doing, quietly and unspectacularly, throughout its life. Its granules, claims Padawer, are chemical processing devices; perhaps even immunological data banks.

To justify his startlingly radical view of the mast cell, Jacques Padawer turns to the hallowed relationship between form and function: if the mast cell exists to discharge its granules, we might expect it to show the characteristics of most other secretory cells; if it doesn't possess such characteristics, the theory is over the first hurdle and the way is clear for an alternative explanation of mast cell function. Speaking at a recent conference in Switzerland on "The mast cell: its role in health and disease", Padawer cited a number of lines of evidence against secretion, of which the following are a few examples:

- Secretory cells contain special organelles to make and package their products, but fully differentiated mast cells contain only a sparse endoplasmic reticulum, and few polyribosomes and mitochondria. If the mast cells actively synthesise proteins for "export", they might be expected to have many more of these organelles.
- The surfaces of cells concerned with secretion are typically covered with tiny projections, or microvilli. The surfaces of mast cells, like those of white blood cells, are covered with what Padawer describes as veils—indicative, he says, of a cell "designed" to ingest material from its surroundings.
- The older the animal, the greater the number of its mast cells; likewise, the older the mast cell, the greater the number of granules it contains. Both observations suggest that granules are laid down to be kept, rather than for continual—albeit irregular—discharge.
- Mast cell granules contain active enzymes rather than their inactive precursors. This suggests that the enzymes are not merely awaiting their eventual discharge, but already doing something *in situ*.

If the overweening ambition of the mast cell is not then to discharge it granules, what is it doing with them? "Broadly speaking," says Jacques Padawer, "I propose that the cells take up material from the extracellular fluid, percolate it over their granules, and return the modified product(s) in whole or in part to the extracellular compartment."

Step by step, the process runs as follows. First, the mast cell membrane takes up material from its surroundings into a vacuole. The vacuole so formed is pinched off from the cell membrane and transported to the region of another organelle, the Golgi body—a process that Padawer has followed experimentally by feeding mast cells with markers, such as plastic microspheres, ferritin, and so on. "Conditioning" of the vacuole contents—removal of cer-



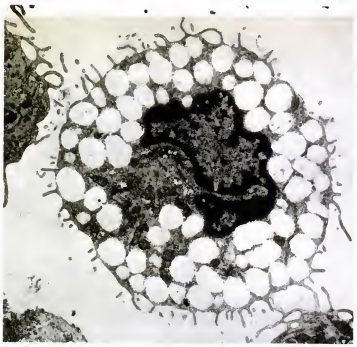
Jacques Padawer and Journal of Cell Biology

The mast cell during degranulation. The cell seems to disintegrate, releasing the potent chemicals in the granules to wreak their havoc

tain mineral cations, for example—begins immediately, and much change has already been effected by the time the vacuoles leave the Golgi region *en route* for their next destination: one of the perigranular sacs that surround each of the mast cell's granules. And here is another departure from conventional microanatomy for, according to Padawer, "Mast cell granules are *not* individually enclosed within a membrane the way an orange is within its peel; rather they are strung out in sets within defined conforming channels, much as sausages within a common casing." The interconnecting holes are tiny in comparison with the dimensions of the complete membrane sac, which is why they are not always seen in the thin sections prepared for the electron microscope. Certainly Padawer's pictures show interconnections between the sacs—though cynics may choose to argue that these are mere artefacts, a consequence of tissue damage during fixation and sectioning.

The vacuole having fused with a perigranular sac, its fluid contents are next milked from sac to sac over a series of progressively more mature granules, finally leaving the cell via transient pores at its surface. This pumping is allegedly powered by actin microfilaments (tiny "muscles") or some other such elements in the cell. Padawer also believes that the cell is constantly adding to its chain of granules, in part by accretion of material from the contents of the vacuoles, which, he says, join the chain at the end still in formation.

Jacques Padawer has no hard evidence of the interactions that might occur between the granules and the materials percolating over them. But he is not short on ideas, and even compares the granular matrix to a laboratory chromatography column. Demonstrating this argument in a film about his work, commissioned by the pharmaceutical company Fisons, Padawer points out that



Jacques Padawer and Marcel Dekker Inc

Padawer's picture of a mast cell with "ghost" granules. When the granules have been extracted it is possible to see interconnections, though not all agree that these are important in processing the chemicals

granules contain not only enzymes and histamine, but a polysaccharide of high molecular weight. "The enzymes could act on the molecules that are taken in, and perhaps transfer a fragment on to the granular matrix. The polysaccharide would act to immobilise those enzymes while at the same time it could serve to bind some component of the percolate. The histamine could participate in an ion-exchange process within this cell and be continuously recycled as in ion exchange chromatography.

An immunological information bank

"As the percolate passed slowly over the granule set, a variety of changes could occur. Antigen/antibody complexes, or fragments thereof, might be bound and retained on the granules. They could subsequently be released to prod the immune system long after the initial stimulus has waned . . . In this way the granules might be acting as a data bank retaining information of value to the body.

"While I believe that mast cells take up material from their environment I do not believe they perform as typical phagocytes. In fact there is an interesting difference between them and macrophages [white blood cells], namely that whereas macrophages can digest readily almost anything they take up, mast cells lack the necessary degradative enzymes and seem to be afflicted with chronic indigestion. If macrophages eat and generally forget, mast cells may eat to remember, because their granules may act as memory stores—stores that have an ever increasing capacity as new granules are formed.

"Alternatively the mast cell could take up and process material quite unrelated to the immune system. We just don't know."

Jacques Padawer concedes that the concepts he is proposing "run ahead of established facts"—a concession with which Padawer's critics would wholeheartedly associate themselves. But, right or wrong, Padawer's suggestions are a tantalising challenge to previous assumptions about mast cell anatomy and function. And surely most tantalising of all is the possibility that the truth about mast cells lies in a combination of Jacques Padawer's ideas with those of Brian Kay. In which case it would be fair to say that we have hitherto grossly underestimated the role of the mast cell in health and in disease. □

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Just for the fun of it

Review

The wages of quicksand

Fear and courage
Stanley J. Rachman
Freeman, pp 319, £3·50

Living with fear
Isaac M. Marks
McGraw-Hill, pp 302, £7·50

Psychologists in recent years have made considerable progress in understanding the workings of human intelligence. Despite the huge gaps in our knowledge, there is now some general grasp of the kind of processes that underlie perception, the use of language and some aspects of human problem solving. Emotions on the other hand remain elusive. The facts are in dispute and the subject is a quicksand for theories.

One of the virtues of *Fear and Courage* is that its author, Professor Stanley Rachman, takes pains to state the unsolved problems. Fear is usually thought of as having three different aspects—the avoidance of the object of fear, a feeling of dread, and the physiological signs that accompany or give rise to this feeling, but when the three are independently measured they often have little correlation. Again, repeated exposure to an event of which someone is terrified may help to reduce his fear—and indeed it is one of the standard methods of treating those irrational fears known as phobias.

But equally, exposure may serve only to exacerbate the fear—most airmen's fears of combat increase in the course of a tour of combat duty even if they have not themselves been wounded. Even the origins of many fears are mysterious: children develop fears of snakes, the dark, spiders, slimy things, the ocean and so on, often in the absence of any untoward experiences or any learning from precept or example. Some of these fears may be innate—chimpanzees show terror when presented with a snake for the first time. But chimpanzees also cower at the sight of an anaesthetised comrade or a mask representing a severed head: how does an animal which presumably has no concept of death develop a fear of the macabre?

As well as setting out the unsolved problems, Professor Rachman gives an excellent exposition of theoretical issues: his book successfully integrates observations on human behaviour in battle with evidence from experimental and clinical studies.

In *Living with Fear* Professor Isaac Marks also points

Ingram Pinn

out some of the areas where our understanding is inadequate: fright usually produces a large increase in heart rate, but the sight of blood may send the pulse rate down to the point of producing fainting. His description of grief prompts one to ask how the mechanism underlying such an incapacitating but universal an emotion could evolve.

Professor Marks takes a pragmatic approach: he deals only with clinical fears and with related aspects of mental illness including sexual disturbances and obsessional-compulsive disorders. His book is illustrated with many fascinating and well chosen case-histories and is unfailingly clear and informative.

His main thesis is that to overcome fear, insecurity or grief one must confront it, and the final section of his book is an admirable guide as to how to set about such confrontation. One hopes that his advice on self-help will be heeded: anyone who can follow it will alleviate their suffering. But one is left with the misgiving that to follow his admirable precepts demands a degree of will-power, persistence and rationality that is beyond those who most need his help.

Stuart Sutherland

The Orbis encyclopedia of birds of Britain and Europe*

edited by John Gooders
Orbis, £7·50 per volume

These volumes complete the *Orbis Encyclopedia of Birds of Britain and Europe*, the first two volumes of which have already been noticed (Review, 8 February, p 395). The treatment of birds by habitats turns out to differ little from the conventional systematic arrangement; the birds of marsh and shore, for example, are the waders, gulls, auks and allied families, those of hedgerow and garden are most of the passerines, though those of heath and woodland are a more mixed collection. As every species of bird that has ever occurred in Europe is included, however accidental a vagrant it may have been, the volumes contain much interesting information about families of birds from America and distant parts of the Old World, a great advantage over many bird books that dismiss the rarities with a few words and give only scanty particulars about their biology and distribution.

Each volume starts with an editorial preface followed by a general introduction, and there is also an introduction to each family, briefly discussing its members worldwide, so that the reader learns far more about birds than the title of the encyclopedia suggests. Each European species is then described under standard headings and is illustrated with a coloured drawing and a distribution map; numerous coloured photographs of the living birds also add greatly to the interest. The printing of the coloured illustrations is good on the whole, though in some the colouring is a little over-emphasised: the green of the wood warbler and the greenfinch, and the chestnut on the throat and forehead of the swallow, for example. The numerous plates of birds in flight are an excellent feature of the books, as are those showing the critical differences between allied species of large families such as the warblers.

In addition to the descriptive matter of the main bulk of the volumes, the editor has included some excellent chapters on selected special topics written by experts. Volume 5 concludes with articles on the feeding habits and adaptation to various diets among the finches; on adaptation and specialisation in the speciation of birds; on the classification of passerine birds; and on gardening to attract birds. Similar essays in Volume 3 discuss the feeding habits of waders in relation to the shapes and adaptations of the bill; and the lengthy migrations of the terns, the longest being that of the arctic tern which travels over 25 000 kilometres, almost reaching the Antarctic in the eight months it is away from its nesting grounds in the Arctic. The population explosion of some species of gull in recent years is great enough to merit the chapter heading "Gulls as pests". Although the invasion of towns, airports and rubbish dumps by gulls creates a nuisance, a possible threat to health, and a real danger to aircraft, the phenomenon is of great biological interest as it involves a change in habits and habitat of the gulls, and a profound effect on the ecology, and even continued existence, of some other species.

The *Orbis Encyclopedia* is a welcome addition to the host of bird books now available because it takes such a wide view of the bird fauna of Europe, and gives answers to the many questions asked by bird enthusiasts seeking more information than is given in less comprehensive works. All the volumes are well indexed, and give lists for further reading. But excellent as is the text, the strongest point of the *Encyclopedia* is the great number of colour illustrations.

L. Harrison Matthews FRS

Volume 3, Birds of Marsh and Shore; Volume 4, Birds of Heath and Woodland; Volume 5, Birds of Hedgerow and Garden.

Review

continued

Fluoridation: The great dilemma

by George L. Waldbott

Coronado Press, pp 423, $7·50

This book by an American allergist, who is a well-known opponent of water fluoridation, is a comprehensive account of the chemistry, metabolism and toxicity of fluoride, written with an eye on what the author believes to be the dangers of fluoridation.

One groundless fear is based on the obsolete work of F. J. McClure published in 1945, suggesting that body storage of fluoride (which Dr Waldbott assumes is harmful) occurs only with daily intakes exceeding 4 to 5 mg. Later work, showing that some storage occurs (in bone) at all levels of intake and cannot be harmful in itself, is not mentioned.

In referring to "idiopathic opacities" on the teeth in low fluoride towns (blemishes resembling and often confused with fluoride mottling), he concludes (p 79) that it is "quite possible" that unsuspected high fluoride intakes are responsible "in most cases"—ignoring the numerous alternative, and more probable, hypotheses. Elsewhere (p 182) he states that "undoubtedly fluoride in tea (which contains an average of 1 part per million even with unfluoridated water) consumed by British children accounts for much of the mottling in low fluoride towns. There is in fact no evidence whatever for this.

The author describes once more his findings of vague and non-specific symptoms in some people drinking fluoridated water. He comments on criticisms of his double-blind tests and states in this book that he has confirmed his results with a procedure which meets the criticisms, but gives no details or references. Symptoms described by R. Finn and H. N. Cohen last year in a few tea drinkers are stated by Dr Waldbott to be "probably due to fluoride". He does not mention that similar symptoms occurred in some people after drinking coffee which contains no fluoride. If fluoridation is harmful why has this not been established by other medical men? Dr Waldbott's answer is that many of them daren't publish their findings, for fear of harassment from the medical establishment, officially committed to fluoridation!

This book has already been widely publicised by the anti-fluoridation movement in Britain and is likely to have great influence in furthering their cause. Its tone is low-key, completely free from emotional outbursts and presents evidence on both sides of the argument with apparent impartiality. Laymen, including those concerned with decisions on fluoridation, will be impressed by what seems to be the reasonableness of the case, oblivious of the omissions and obsolete presuppositions upon which much of it is based.

G. Neil Jenkins

Chemistry from the USSR

Rarely do we receive English editions of chemistry texts from the Soviet Union. However, Mir Publishers (Moscow) has recently produced translations of several widely-used student books. One of these is **Physical chemistry of polymers** by A. Tager (pp 653, £4·50). Said to be the most popular study aid on the subject in the USSR, the book is a revised second edition and contains information on polymer synthesis and structure; phase states and transitions; and mechanical, rheological and electrical properties. Also discussed are the theories, structure, properties and thermodynamics of polymer solutions and gels. Sections are included on plasticisation, the gas permeability of polymers and polymeric sorbents, and ion exchange resins. Unlike many other texts, it does discuss inorganic polymers. The book suffers from the disadvantages of: predominant referencing to Russian work, poor quality of production, classical literary style, occasionally clumsy translation and inadequate illustrations. However, it is comprehensive and gives unique coverage of this topic. While it delves too deeply into the subject for most UK undergraduate courses, its uniqueness should make it of value to polymer specialists.

Another text, **Fundamentals of organic chemistry**, Vol 4, by A. N. Nesmeyanov and N. A. Nesmeyanov (pp 505, £4·50) comprises the second part of a 4-volume book intended to provide a systematic coverage of organic chemistry. Part One—the first three volumes—is a classical approach to the chemistry of various functional groups, subjects covered in the early part of a UK undergraduate course. The volume under review deals with more complex topics which are best grafted onto the framework of knowledge from the student's earlier systematic study. The subjects include: non-benzenoid aromatic systems, carbanions, free radicals, carbenes and carbonium ions; some physical organic chemistry (mechanisms and types of reaction); a brief look at natural product chemistry (isoprenoids and alkaloids); and an introduction to biochemistry—proteins, nucleotides, polynucleotides and enzymes. This book has the same disadvantages as the other Mir publication, and does not compare well with the many other modern, well-presented texts on organic chemistry.

The third translation is entitled **Chemical thermodynamics**, by M.Kh. Karapetyants (pp 690, £5·95). This book explains the laws of thermodynamics and the principles of thermochemistry. The author then describes the thermodynamics of one-component and multi-component systems, solutions and chemical equilibria. The last chapter deals with a topic not normally covered in comparable books: the calculations of thermodynamic functions from spectroscopic data. Again the work suffers the inadequacies of the other two texts, in addition to which there are occasional excursions into metaphysics—especially during the discussion on the invalidity of the "theory of heat death of the Universe", where even Lenin gets a mention. Thermodynamics is a difficult subject and many students need to refer to several books before understanding a particular topic. Only on this basis am I tempted to recommend Karapetyants's *Chemical Thermodynamics* text for college libraries, but not for individual purchase. *Gordon Wilkinson*

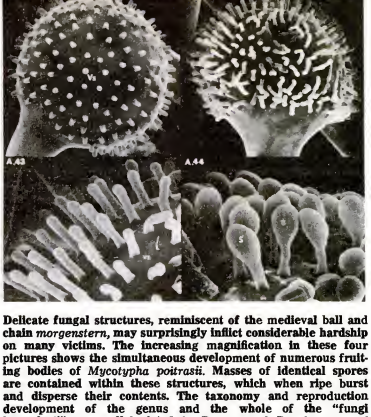
new from Manchester

THE CHALLENGE OF MICROPROCESSORS
SELECTED READINGS FOR ENGINEERING EDUCATORS

Michael G Hartley and **Anne Buckley** (editors)

This book draws on the experience of the Digital Processes Group and members of the Microprocessor Unit at UMIST, together with academic colleagues worldwide. Its emphasis is on the problems of what to teach in the microprocessor area and the most effective method of presentation. After a brief introduction to microprocessor technology comes an up-to-date survey of the state of the discipline. Successive contributions cover laboratory facilities and 'hands-on experience', discussion of specific experiments and the organisation of short courses for industrialists. The Microprocessor Engineering Unit at UMIST is described as an example of a response to a real need for teaching, advice, consultancy and retraining. The book concludes with a select list of books and journals relating to microprocessors. £10.00 approx July

MANCHESTER UNIVERSITY PRESS
Oxford Road Manchester M13 9PL



Delicate fungal structures, reminiscent of the medieval ball and chain *morgenstern*, may surprisingly inflict considerable hardship on many victims. The increasing magnification in these four pictures shows the simultaneous development of numerous fruiting bodies of *Mycotypha poitrasii*. Masses of identical spores are contained within these structures, which when ripe burst and disperse their contents. The taxonomy and reproduction development of the genus and the whole of the "fungi imperfecti" are well-depicted in *Patterns of Development of Conidial Fungi*, by G. T. Cole and R. A. Samson (Pitman, pp 190, £29·75). This up-to-date treatment by electron microscopy will be useful to many microbiologists and pathologists. *M. McHarg*

Dangerous properties of industrial materials

by Irving N. Sax

Van Nostrand Reinhold, pp 1118, £39·50

Reviewing Sax is like seducing Brigitte Bardot (I imagine)—the object is worthwhile but one stands in awe before the prospect. For Sax is one of those books that has a biblical status, taken down from shelves to be consulted in times of doubt, referred to as a source of unquestioned wisdom, but not exactly readable.

The largest section of the book—and the source of its amazing usefulness—is an alphabetical listing of 16 000 substances and their hazards, cross-referenced to a catalogue of suggested precautions for handling chemicals. Of these substances, 2500 are new to this (fifth) edition—indicating the fantastic rate at which the list of dangerous chemicals is growing.

But there are also chapters contributed by knowledgeable scientists on matters such as industrial noise, designing ventilation systems, cancer-causing chemicals, radiation and so on. Some of these are more useful than others and some are not very well written.

There is, however, one note of caution that needs to be sounded about this kind of book (although I hesitate to do so given the authority of Sax's efforts). Science's knowledge about the toxic properties of materials is growing apace. Almost every month there is a major discovery about some fairly common chemical. How reliable, therefore, is a hard-backed book that has probably taken two years to write and publish as a guide to these properties? By the time this edition of Sax hits the streets, at least three or four important entries in the catalogue will be seriously outdated. Still, until industrial safety officers, managers, factory inspectors and others who currently rely on Sax have computer terminals in their offices giving them access to the latest data, Sax will be indispensable.

Lawrence McGinty

Multimedia

Science and religion*

A concern for social responsibility in science and technology —which avoids the excesses of anti-science romanticism and also of Marxist political commitment—marks a broad front of current UK publications and organisations including, say, *New Scientist*, the Council for Science and Society and the British Association for the Advancement of Science. In such good company, this study pack provides articles, cassette recordings and questions for discussion that are well suited to study and discussion groups of students and concerned citizens.

Material is presented by postdoctoral scientists, who appear to share a basic ideological commitment to a radical Christian humanism and who are particularly concerned to bring science and religion together.

The material includes: "Is there a conflict between science and religion?" "Why bother with science?" "Genetic engineering," "The history of science and religion," "Science and technology" and, almost inevitably, "Microprocessors and automation".

The questions suggested for discussion are useful if obvious. What is rather taken for granted is the liberal humanist and ethical Christian background that (it is implied) can inform the answers. But then I share this stance for I am involved in parallel discussions on Merseyside and internationally, both as a Christian and as a scientist. So are many other Christians (see, for example, "Scientists who believe in God," by Ian Breach, *New Scientist*, vol 74, p 478)—in fact, I would guess that the *New Scientist* readers include a surprisingly high percentage of active Christians, probably higher than, say, those of *New Society*.

I hope that this study pack is used widely. Perhaps others will be encouraged to produce their own. It would be useful if future material were to include not only scientific but also theological/biblical and liturgical material and also if some of the questions were aimed to provoke discussion on the nature of the specifically Christian contribution to social and technological problems.

Eric Jenkins

*Science and religion: a study pack, edited by David Wharton, The Student Christian Movement, Wick Court, Wick, near Bristol, pp 40 and 2 × 30 min. lectures on cassette, £4·50.

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Bernard Gilland

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1979 144pp £9·50 ISBN 0 85626 176 9

ABACUS PRESS
Tunbridge Wells, Kent

Review
continued

Heritage

Chemistry's White Knight

Augustus Vernon Harcourt

The pages of Alice's adventures in dreamland contain fascinating records of Victorian characters who lived and worked in the Oxford of her creator, Lewis Carroll. Among them was the distinguished chemist Augustus Vernon Harcourt

The Knight went on again. "I'm a great hand at inventing things. Now, I dare say you noticed, the last time you picked me up, that I was looking rather thoughtful."

"You were a little grave," said Alice.

"Well, just then I was inventing a new way of getting over a gate—would you like to hear it?"

"Very much indeed," said Alice politely.

"I'll tell you how I came to think of it,' said the Knight. "You see, I said to myself 'The only difficulty is with the feet: the head is high enough already'. Now, first I put my head on the top of the gate—then the head's high enough—then I stand on my head—then the feet are high enough, you see—then I'm over, you see."

"Yes, I suppose you'd be over when that was done," Alice said thoughtfully, "but don't you think it would be rather hard?"

"I haven't tried it yet," the Knight said, gravely; so I can't tell for certain—but I'm afraid it would be a little hard."

One thing that Augustus Vernon Harcourt was not afraid of was hard *scientific* work. Harcourt, born in 1834, came from a distinguished and privileged family, with a history dating back to the medieval Duc d'Harcourt. Grandson of the Archbishop of York and son of an admiral, Harcourt arrived in Oxford in 1854 to read classics in the family tradition. But his attention soon turned to chemistry.

Among the most interesting aspects of Harcourt's long career at Oxford was his friendship with Charles Dodgson, fellow member of Christ Church College and author (as Lewis Carroll) of the immortalised Alice tales. Dodgson had entered Christ Church three years before Harcourt's arrival in Oxford. The number of entries in Dodgson's diaries, now in the British Museum, dating from 1855 to just before his death in 1898, show how frequently the two spent time together, and with other Oxford figures like the Brodies, and the Liddells. Sir Benjamin Brodie was then professor of chemistry and Harcourt's mentor, and Alice Liddell was the young daughter of the Dean of Christ Church. During the first week of August 1862, the diaries show that Dodgson and Harcourt spent much of their free time with the Brodie and Liddell children:

1 August, 1862: As the Dean's children are still here, Harcourt and I went over to see if they could come on the river today or tomorrow, and remained a short time. . . .

5 August, 1862: After dinner Harcourt and I went to the Deanery to arrange about the river tomorrow, and stayed to play a game of "Ways and Means" with the children. . . .

It was around this time too that the tales of Alice were born, for Dodgson wrote:

6 August, 1862: In the afternoon, Harcourt and I took the three Liddells up to Godstow, where

Alice meets the White Knight

we had tea: we tried the game of "The Ural Mountains" on the way, but it did not prove very successful, and I had to go on with my interminable fairy-tales of Alice's adventures. . . .

These golden afternoons spent on the quiet waters of Oxford were to be remembered by Dodgson many years later, with the poignant words:

A tale began in other days,
when summer suns were glowing—
A simple chime, that served to time
the rhythm of our rowing—
whose echoes live in memory yet,
though envious years would say forget.

But with the publication of *Alice Through the Looking Glass* in 1871, the envious years brought the opposite—the tales begun in other days became etched in the memories of millions, not only in Britain, but around the world.

Many years later, Alice was to recall the same golden days on the river:

"One of our favourite whole day excursions was to row down to Nuneham and picnic in the woods there, in one of the huts specially provided by Mr Harcourt for picnickers.'

"Mr Harcourt" was the Rev William Vernon Harcourt, uncle of Augustus, who though himself an enthusiastic, "amateur" chemist, is now chiefly remembered as the founder of the British Association for the Advancement of Science.

Inventive characters

The link between Harcourt, Dodgson and Alice is a closer one than that they merely knew each other. Enthusiasts of the Dodgson tales have always accepted that the characters in the Alice books relate to personalities associated with real lives in 19th century Oxford. Surrounded as they were by the most select of the university dons, as well as many notables of the day, including the Prince of Wales, Dean Liddell's children must have spent many an enjoyable hour matching the story characters with those they knew.

The tale, still told in Oxford scientific circles today, is that the White Knight's flair for invention was a reflection on Harcourt, who was, without a doubt, a highly innovative and successful inventor. Sometime during his long scientific career, Harcourt was responsible for the chloroform-inhaler which was adopted by the British Medical Association as satisfying the minimum dose necessary to secure anaesthesia during operations without endangering life. In another sphere, his interest in the properties of gases led to his appointment as one of the three "Metropolitan Gas Referees" responsible for testing the safety and levels of purity of gas used in London. This led to the introduction of the Harcourt pentane-lamp as the official British standard of light, a standard which was to last until the 1930s.

Dodgson, who was a frequent visitor to the Harcourt home, was also very fond of inventing things, as many authors have pointed out. Commonly, scholars of Dodgson's work believe that the White Knight is in fact a caricature of Dodgson himself, not only because of his obvious knack of inventing things, but because of the special relation between the Knight and Alice.

Schiele family

Portrait of Harcourt as president of the Chemical Society

Dodgson himself wrote in a letter that the character of the White Knight was meant to suit the speaker in the poem, who was undoubtedly an eccentric inventor. Such a description neither perfectly fits Harcourt the scientist, nor the highly imaginative and mathematical Dodgson. Harcourt, however, was sometimes absentminded, as Dodgson recorded. "Harcourt had asked me to come and dine with him and Mrs H. I arrived at the hour fixed ($7\frac{1}{2}$), and had a very pleasant chat with Mrs H. till past 9! when Harcourt arrived, having forgotten all about it, and gone on in the laboratory."

But it is in the chemical parallels between Harcourt and the tale of the White Knight that the temptation to draw an analogy is greatest. Harcourt's contribution to chemistry was unique in many ways. He recognised at a very early stage that what chemists had always neglected was the close observation of the actual *course* of chemical change, of the time factor involved in these changes. The key to chemical processes lay in finding mechanical laws. The foundations for these ideas were laid at the very beginning of Harcourt's long career at Oxford, but he was to spend the subsequent 50 years perfecting his techniques. Together with the mathematician, and his lifelong friend, William Esson, Harcourt was to labour:

"Shoulder to shoulder . . . Harcourt planning the experiments, both checking one another's observations of time intervals, Essen doing the calculations . . . it was pioneering work, flawless in execution, and mathematically sound, its method prevails till this day"

wrote a later fellow of the Royal Society. Forty-seven years were to pass between the first paper by Harcourt and Esson in the *Proceedings of the Royal Society* in 1865, and their last paper together in *Philosophical Transactions* of 1913.

It is not difficult, and all too tempting, to see a parody of the chemist labouring in the laboratory by a close bystander, as Dodgson was.

Schiele family

Schiele family

Harcourt with Professor Sir Benjamin Brodie and his family. The photographer is unknown, but Dodgson, a keen and early enthusiast, took portraits of Harcourt as an undergraduate and later of his children. Below *The looking-glass fireplace, one of Harcourt's many inventions. The fire covered the whole height of the fireplace and the fuel was laid in layers, separated by grids; on top of this was laid ordinary firewood. When lit, the fire would burn like a time piece, exposing each layer in turn. It was highly efficient, as his daughter now recalls, and never needed stoking*

"Now the cleverest thing of the sort that I ever did," he went on after a pause, "was inventing a new pudding during the meat course."

"In time to have it cooked for the next course?" said Alice.

"Well, that was quick work, certainly."

"Well, not the next day," the Knight said in a slow thoughtful tone: "no, certainly not the next course."

"Then it would have to be the next day, I suppose you wouldn't have two pudding courses in one dinner."

"Well, not the next day," the Knight repeated as before, "not the next day."

"In fact," he went on, holding his head down, and his voice getting lower and lower, "I don't believe that pudding ever was cooked. In fact I don't believe that pudding ever will be cooked. And yet it was a very clever pudding to invent."

"What did you mean it to be made of", Alice asked, hoping to cheer him up, for the poor Knight seemed quite low-spirited about it.

"It began with blotting-paper," the Knight answered with a groan,

"That wouldn't be very nice, I'm afraid. . . ."

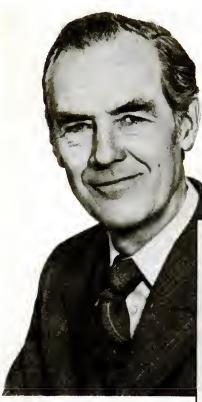
"Not very nice alone, he interrupted, quite eagerly, but you've no idea what a difference it makes, mixing it with other things—such as gun-powder and sealing wax. . . ."

Harcourt and Dodgson remained close friends during their long careers at Oxford. Certainly Dodgson's extensive diaries record many visits to Harcourt's ancestral family home at Nuneham and London with his friend, whose company he obviously enjoyed. It might be thought strange that so few letters between Dodgson and Harcourt exist, among the many that have survived. As Professor Morton Cohen points out in a forthcoming edition of *Dodgson's Diaries*, this attests to the closeness of their friendship rather than the opposite. In the days when no telephones existed, every piece of communication was by paper, and a great deal more was recorded for posterity than today; however, the exception was when the persons met frequently.

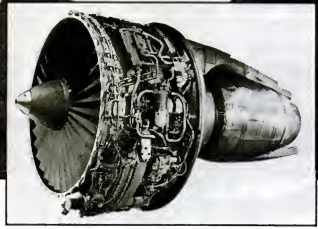
Whether the White Knight was Dodgson himself, or a caricature of his chemist friend Harcourt, or, more likely, a conglomeration of both and more besides, remains a fascinating conjecture. Harcourt was certainly there when the tales of Alice were conceptualised, and was present at the end, to witness Dodgson's will.

"Ever drifting down the stream, Lingering in the golden gleam, Life, what is it but a dream?" wrote Dodgson of those halcyon days. The quality of Harcourt's superb chemical labours of 50 years has been appreciated by many a chemist since, but it is the chemical exploits of Alice's White Knight which continue to intrigue. *Christine King*

These two gentleme when they see it.



Ross Stainton
Chairman, British Airways



RB211 Large Fan Series

William T. Seawell
Chairman, Pan American World Airway

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The aerodynamic design, analysis and performance development of axial flow compressors, turbines, aircraft intakes, cowlings and nozzle systems are fundamental to gas turbine engineering. This work provides considerable scope for innovation in such fields as applied theoretical and experimental fluid mechanics aero thermodynamics and computer technology. A degree or good HND in mechanical or aeronautical engineering, mathematics or physics, are all appropriate to these positions.

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Development Engineering at Rolls-Royce involves the thermodynamic and mechanical behaviour of aircraft engines taken as a whol or in their component parts. We are looking strongly analytical yet imaginative men and women who can communicate ideas and rel with others. It requires a practical interest in

know a good thing

mechanics, thermodynamics and aerodynamics. As a Development Engineer you will be asked to define and solve a wide variety of problems within a prescribed time-scale and you will have at your disposition a large volume of resources in the form of development engines, rigs and advanced technical devices, to enable you to do this and to prove your solutions.

Candidates should have a Degree or HND (or a pre '68 HNC), preferably in Engineering, although Mathematics, Physics and other scientific graduates will be welcome. We will provide on-the-job training for those candidates who have the motivation and potential but who lack the experience we seek.

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Engineering Design at Rolls-Royce is a key function demanding conceptual thinking, innovation and creativity along with a good knowledge of current and future technology.

The work calls for experienced Mechanical Designers who can use information from teams of specialists in the field of stress, aerodynamic, heat transfer, metallurgical and combustion problems associated with gas turbine design to achieve optimum solutions despite the often conflicting requirements of high performance, long life, low cost, low weight, etc.

The Designer's task is to produce a scheme from which detailed manufacturing drawings can be prepared. The Designer draws upon the data produced in specialist areas in order to define the 'best' concept to produce a competitive product which meets the exacting specifications from aircraft contractors and customers. This synthesis is an essential and satisfying part of design at Rolls-Royce.

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Stress & Vibration

Stress and vibration engineering at Rolls-Royce presents a particular challenge because of the extreme conditions of vibration, stress and temperature under which gas turbines and their components must operate.

We need highly responsive men and women with an interest in and preferably knowledge of these fields who can look beyond the straight facts and figures provided by test and calculation; who can sense possibilities and the probable outcome by a mix of flair, training and experience; who can use to maximum advantage the powerful on-site computers supporting the engineering function.

Applicants should have a Degree or HND in mechanical engineering, mathematics, or an associated discipline (e.g. physics) and some relevant post graduate or industrial experience would be an advantage.

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Applicants should be of degree standard in Mechanical Engineering, Physics or Mathematics and have a particular interest in fluid dynamics or heat transfer. Experience in these fields or in computing would be an advantage.

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The creation of technologically advanced gas turbines by highly skilled engineers requires the backing of a large computational facility. This is provided by one of Europe's largest computer complexes in manufacturing industry, using vector display terminals to give the engineers their data as rapidly as possible and in a form which is easily assimilated. Work is proceeding with large computational systems that deal with blade design, finite element modelling, data recording and analysis, amongst others.

We require people with an interest in the application of computers to the solution of engineering problems to devise mathematical models of the physical processes and to write the interactive and batch programs that constitute these systems. Applicants will be expected to have a degree in a numerate discipline, particularly Mathematics or Computer Science. Successful candidates will join a young department with all the latest computer technology in use.

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☐ HND ☐ DEGREE
☐ SUBJECT

NO. OF YEARS EXPERIENCE
☐ 0-1 ☐ 1-2
☐ 2-3 ☐ 3+

CURRENT JOB
TYPE OF WORK
EMPLOYER'S PRODUCT

INDICATE PREFERRED AREAS OF INTEREST:
☐ AERODYNAMICS ☐ DEVELOPMENT ☐ ENGINEERING DESIGN
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Forum

A GROUNDLING'S NOTEBOOK

Watch out, trout

Donald Gould

There was an appalling item of news in the *Guardian* the other day. Indeed, there were several appalling items of news in the *Guardian* the other day. There always are. The particular issue to which I am referring was full of comment and information on that shameful budget, which is going to accentuate the poverty of the poor and further soften the easiness of the well-to-do. It held news of another bomb planted by Irish psychopaths in a Birmingham postal sorting office. It reported the death of John Wayne, which rates, I suppose, as a cosmic disaster. It described the arrival in this country of Vietnamese boat people, driven from their homes by cruel politicians of a kind common in the world today, and who prove that the nature of man has not improved by one jot or one tittle since the days of Genghis Khan, and despite the sacrifice of Jesus Christ. It contained yet another instalment of the tragic tale of Jeremy Thorpe and his friends. It told of the loss of a plane and its crew in the Irish Sea. It named a British couple killed when a crane collapsed upon them while they were holidaying in Switzerland. It noted that the "legal" slaughter of people found guilty of "anti-state crimes" in Ghana was expected to start in the following week. And it carried an advertisement inviting applications for the post of sociologist with the Lambeth Borough Council (as if local government in this scepter'd isle hasn't troubles enough already, dammit).

But among all these frightening and depressing pieces of intelligence, one stood out above the rest. It was a piece written by the *Guardian's* estimable and redoubtable science correspondent, Anthony Tucker, and headed "Male trout made redundant".

This was a description of the manner in which men trout reduce the prosperity of fish farmers. It seems that the little buggers (come to think of it, that's a wholly inappropriate epithet) not only turn themselves into something less than a choice dinner dish, but also sadly diminish the gustatory appeal of the lady trout within their domain. You see, they expend an enormous amount of energy in chasing around their pond after the fishy floozies. In so doing they become thin and stringy. That would be bad enough, but worse follows. They not only turn themselves into the kind of joyless lean and hungry animal that may be commonly observed jogging in unhappy way around Hampstead Heath of an early morning—they also spoil the flesh of the ladies.

Lady trout, we may assume, can't read, and are therefore ignorant of the insights concerning self-fulfilment of the kind to be found in such major philosophical works as Dr Alex Comfort's treatise on the joys of sex. To be blunt, they don't like it. They waste their energy in attempting to preserve their virginity, and in striving to evade the attentions of the lusty males. They, too, therefore, dart furiously all day, and become skinny, tough, and sour.

The extraordinary tale which Anthony Tucker has to tell is that scientists at the Lowestoft research laboratory of the Ministry of Agriculture, Fisheries and Food, have been able to turn "genetically female fish" into "functional males" by hormone treatment. It seems that these "masculined females" actually produce sperm, which can fertilise normal eggs. But since they are genetically female, their sperm contain only X chromosomes, and so all their offspring are little girl trout, and the demon sex bows its ugly head, and peace reigns within the fish pond, and all its denizens become fat, slothful, and delicious.

I have to admit that I don't fully comprehend the tale as told by A. Tucker. I don't quite understand why a "masculined" (shouldn't it be "masculinised"?) lady trout should be any less fervent concerning under-the-sheet affairs than their natural counterparts. But let that pass. My principal concern is that these damned clever scientists have discovered how to make the men of one species redundant.

We had a hint of it a long time ago, not by the grace of science, but simply by the process of evolution. Look how bees treat the male members of their tribe. And do you know what the lady mantis do to their menfolk? Having enjoyed (presumably) a night of love, they *eat* them.

I have always suspected that men have historically been prime ministers, and archbishops, and chairmen of boards of directors, as a result of their desperate need to demonstrate to themselves that they do really count for something in the living world. If they can't have babies, then they can at least make war and fix interest rates.

But I fear that Mistress Thatcher, and the scientists at the Lowestoft research laboratory of the Min of Ag, Fish and Food, have, between them, shown that we males are dispensable, and on the way out. □

LUNATIC FRINGE

Wizard idea

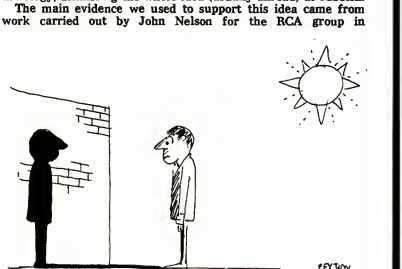
John Gribbin

If you want to annoy a "real" scientist, creep up and whisper "astrology" in his ear. All that lunatic stuff about how the positions of the planets affect our lives here on Earth—so imprecise, so unscientific. The outraged reaction of establishment science to the occult, of course, only serves to make it more respectable in the eyes of many people. If those weirdoes say it's crazy, they argue, then there must be something in it. The success of Velikovskian ideas is a case in point—these gained enormous publicity from their flat rejection by establishment science, and though now a few careful scientists have offered reasoned refutation of them, they have taken root too strongly to disappear overnight.

The trouble is, as well as giving really crazy ideas publicity which only helps them, establishment scientists also flatly refuse to accept just a few ideas which *sound* crazy but really do work. Dowsing is one example, now slowly becoming respectable; the influence of the planets on the Sun is another, still regarded as crazy in most quarters but thoroughly established for anyone who cares to look with an unprejudiced eye.

Of course, I'm prejudiced, as anyone who has run across a slim volume called *The Jupiter Effect* will know. In that book, Stephen Plagemann and I developed the speculative idea that solar activity, by affecting the spin of the Earth, could provide a trigger for earthquakes. We backed this up with what seemed to us very solid evidence that the positions of the planets affect solar activity—and the critics leaped upon us with cries of astrology, dismissing the whole idea (usually unread) as rubbish.

The main evidence we used to support this idea came from work carried out by John Nelson for the RCA group in



the United States. For more than 20 years Nelson predicted solar activity—and hence changes in radio propagation conditions here on Earth—from the alignments of the planets. He knew nothing of astrology when he started this work, but evolved independently rules of thumb relating right angle, 60° and other alignments of planets such as Saturn, Mars and Jupiter which exactly echo those claimed to be significant by astrologers. RCA knew nothing of astrology either—all it knew was that Nelson's system worked, and saved them money. Once the news got out, Nelson suffered ridicule and rejection by established science—but still the technique worked.

Now, having retired, Nelson has written his story up for publication—not with a major scientific publisher (the taint of astrology still lingers) but from the Radio Bookshop's "73 Library", a technical series for radio enthusiasts (who, of course, don't care *how* it works as long as it does work), under the title *The Propagation Wizard's Handbook*.

Maybe the influence of these ideas will now begin to leak out and encourage a change of attitudes comparable to the changing attitudes towards dowsing. Certainly the fear of upsetting the establishment has proved a deadening hand in the past—just after *The Jupiter Effect* was published, Steve Plagemann, then working at NASA, was approached by a colleague working in the same building. "You know", he said, "I'm really glad to see that stuff in print. I've been working on predicting solar flares for years, and I've got a file of evidence which shows a definite relationship with Jupiter-Saturn alignments. But I daren't put that in my report—it's more than my job is worth". Steve, of course, is now farming in Ireland, while his anonymous colleague still has a desk job in NASA. Make up your own mind who has the best deal.

But maybe you want a prediction. So I'll give you one, not from Nelson himself, but using my interpretation of his technique. At midnight on 1 December, 1980, all the planets will be grouped in a rare right angle alignment. Look out then for solar activity linked with severe magnetic storms and bright aurorae on Earth. If you are crazy enough to believe the Gribbin-Plagemann theory of solar-terrestrial links, look out also for earthquakes. And if you're an astrologer, watch out for the triggering effect of the Moon, one hour earlier at 11 pm on 1 December. Meanwhile, for a fascinating book well worthy of general circulation, try to get hold of *The Propagation Wizard's Handbook*, and find out what it's all about. □

THOUGHTS OF SORTS

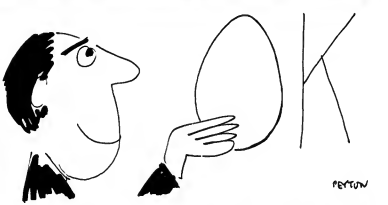
Enter the egg baron

Colin Tudge

I have just bought another flock of chickens, without which no suburban semi is complete. With my head full of egg, I feel it is time to answer the notorious abuse that so valuable a commodity has suffered this decade past.

Time was when eggs vied with milk for top place in the food mythology stakes. They contained vitamins, and vitamins were, er, vital; and they contained protein of such high quality that all others were measured against it; and high-quality protein—so called "first class protein"—was thought to be what stood between all-American rude health and the sickliness that has been the lot of most of humanity. The battery egg boom was fired mainly by commercial opportunism—a high quality agricultural product produced virtually without labour; whoever had heard of such a thing?—but behind it too was the feeling that all was justified because eggs were good. If people objected to the self-evident cruelty to hens, the new farmers could always ask the critics whether they thought chickens were more important than children?

Then the fashion changed. It became clear that malnourished children usually did not lack high quality protein specifically but were short of food in general; and since battery chickens ate grain which could, theoretically, prevent children's malnutrition almost as surely as the eggs might cure it, it seemed the battery hen was not so much a benefactor, as a rival. Moreover, the world—and particularly the Americans—discovered cholesterol. High blood cholesterol equalled atheroma equalled



heart attack. And if it was a bad thing to have too much cholesterol in the blood, it must also be a bad thing to eat it. Eggs, though not the richest source of cholesterol (that dubious honour belongs, triumphantly, to brains) are in practice, by far the most significant single dietary source. Ergo, said many American intellectuals, eggs are bad; and some, like Professor Henry Blackburne of Minnesota, said it so loudly that the egg barons sent their lawyers round, and subpoenaed his research notes. Others, like Bill Castelli, one of the guiding lights of the famous prospective study on heart disease at Framingham, near Boston, Mass, still advise people to eat eggs without their yolks, which harbour all the cholesterol; though since the yolks also harbour most of the flavour, the benefits of the yolkless egg are none too clear.

The fault, as ever, lies in extremism. Chickens in the back garden need a little bit of corn to tide them over, but for the most part they eat leftovers, peelings, weeds, and snails, which would otherwise be wasted or wreak havoc; so they are all bonus. High blood cholesterol may be bad; but as the Royal College of Physicians intimated in its report on coronary heart disease in 1976, dietary cholesterol is not the only extraneous force that raises blood cholesterol. Dietary saturated fat will also do so, and the amount of cholesterol in our food is so small compared to the amount of saturated fat, that in practice it probably hardly matters; and even Professor Blackburne had admitted that an ovo-vegetarian diet would be no bad thing, assuming it contained no grisly saturated vegetable oils, (such as coconut). The high quality of egg protein remains beyond dispute, and although high-protein diets are no longer considered *de rigeur*, the United National Protein Advisory Group suggests that a little high-grade animal protein is at least a desirable guarantor of quality in a predominantly vegetable diet.

Furthermore, eggs are the only protein apart from milk (and blood, according to the Masai; but they are eccentric fellows) that you can get from animals without damaging the animal. Indeed extending the principle, it is possible not only to obtain an almost-free, highly valuable and continuous pay-off from domestic birds, like chickens, but also to cull wild birds. It has long been standard and respectable practice to take the earliest clutches of plovers, which have a poor chance of survival. That new and strident phenomenon, the urban seagull—poisoned, shot at, and assaulted by councillors with fireworks on long thin sticks—could be regarded as an asset, if brave youths cared to risk its beak and cull its eggs; easier, by far, than the natural sea-cliff. The ostrich egg has long found favour; and since the dominant hen kicks out all surplus eggs from the communal nest (carefully conserving her own, as Brian Bertram now records in *Nature*, vol 279, p 233), these can be nicked with a clear conscience.

For the time being, and with equally clear conscience, I shall stick to chickens. But there's a whole resource out there. □

PERSPECTIVE

Smokescreen

Lawrence McGinty

It was with some surprise—and mounting annoyance—that I read our man in Westminster's column the other week (14 June, p 937). There was Tam Dalyell writing in glowing terms about the Department of Trade's new regulations to stop manufacturers marketing furniture that burns like a funeral pyre

Forum
continued

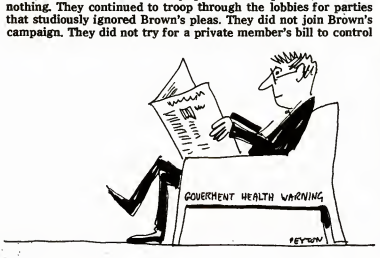
because it contains polyurethane foams. I have no argument with the department's intent—except that its regulations do not go far enough because they do not ban furniture that is difficult to ignite but evolves masses of toxic fumes and smoke when it does get going. What surprised me was that Tam Dalyell laid these new regulations at the feet of Ron Brown MP as reward for his 11-year campaign against dangerous plastics in furniture. The latest government moves are, as Tam Dalyell tells it, a "triumph" for Brown. Ron Brown it was who "was responsible" for the creation of the government committee whose meditations led to the new regulations.

Well, I have nothing against Ron Brown (who is a cut above the average boring, anonymous, inefficient back-bencher). It is quite true that Brown has campaigned long and hard against plastics in furniture that more closely resembles a roman candle than a decent chesterfield. It may even be that other MPs would have given up in despair when Brown pressed on regardless. But it is also true that Brown raised one of the smelliest red herrings in the whole debate about plastics and fire—with his claim (later disproved) that polyurethane foam can ignite "spontaneously". And it is equally true that a great many others have campaigned just as long and just as hard as Brown. Scientists in the Greater London Council's scientific branch for example (and Alan Berman in particular) were pointing out almost a decade ago that the British Standards Institution's tests for the ignitability and fire properties of plastics were useless. Indeed, Alan Berman wrote an article for *New Scientist* five years ago spelling out exactly what happens when "modern" furniture goes up in flames. And the picture he painted then has not been seriously flawed by any of the research that the government has sponsored in the past five years. Not only do many plastics in furniture ignite more easily than the materials they replaced, Berman explained, they also spread fire more quickly, reach higher temperatures, give off more smoke, and liberate very toxic fumes.

To blow our own horn, *New Scientist* campaigned on this theme for some years both before and after Berman's article. So did some national newspapers (pathetically few, it is true). So did some television programmes. And above all, so did the fire brigades—the people at the sharp end who noticed that modern furniture fires were fearsomely difficult to extinguish and did so long before the scientists came round to "proving" this observation in the laboratory. All these people deserve as much credit as Brown—if not more—for the government's belated legislation. I say more because a scientist staking his reputation by arguing against a strong industry lobby is often putting his head on the chopping block, whereas an MP doing the same is merely earning his corn.

But what really annoyed me about Tam Dalyell's valediction of Brown's campaign was that he quoted it as a stirring example of the usefulness of back-benchers. In fact it is the exact opposite. Brown has been arguing in parliament for a decade, with good evidence to support his case. Yet Conservative and Labour governments did precisely nothing about the hazards to which he drew attention. And, more importantly in this argument, back-benchers of every political complexion, also did nothing. They continued to troop through the lobbies for parties that studiously ignored Brown's pleas. They did not join Brown's campaign. They did not try for a private member's bill to control the hazards. If anything, the whole sorry story of the fire risks of modern furniture exemplifies the plain lack of guts that many MPs display when faced with the inevitability of arguing a case that upsets a major industry. Brown is an honourable exception.

Where were Tam Dalyell and the other 500-odd back-benchers when Brown was beating his head against the parliamentary brick wall? For 10 years or more people have been dying in fires that need not have happened (or need not have been life-threatening) if parliament and its members had been doing the job we elect them to do. Sorry Tam, I see the new legislation not as a triumph but as an example of the total inadequacy of British political structures to control hazards. □



MEDIA MESSAGES

Post Office power

Tim Robinson

Passing across the empty fastness of Blackheath the other day my attention was riveted by a giant hot air Buzby looming in the sky; a small crowd watched with consuming interest as it swayed and bobbed in the wind. The Post Office publicity machine no doubt, scoring a small triumph.

The Post Office looms large in all our lives—perhaps more than you might imagine. Over the years, and, remember, it has been here since the mid-19th century, it has slowly enlarged the range of its activities to cover *all* the means of sending information. Where it has not managed a monopoly it consistently bullies and cajoles its rivals.

First, to convince you I tell no lie about its breadth of concern turn to the front of this magazine where you will see *New Scientist* is registered at the Post Office. Now I know as well as you that this registration is a simple device to ensure lower postal charges; nevertheless it does require the listing of all those publications (just about every one of any note) not wishing to be charged by weight for posting to readers.

At the other end of the scale it has a monopoly of letter delivery as effective as possible. Again it *is* possible to send letters by hand, or through small agencies set up to deal with highly sensitive documents; but although the PO charges frightful amounts I can assure you it remains by far and away the cheapest.

There is an argument which would base the Post Office's control over postal delivery on simple efficiency; as far as that goes I agree. The Post Office, however, has moved far beyond such old-fashioned information transmission systems.

It began with the telegraph back in the 1860s when the GPO took to itself the right to transmit all telegrams in Britain. From that point it was logical for it to extend those powers to cover wireless telegraphy (in 1904). And in 1912 the GPO nationalised all telephone systems except those owned by Hull and Portsmouth city councils.

Once again there is some kind of logic in seeing a relationship between letters and telegrams; both are written, the latter bing a truncated form of the former. Wireless transmission is, then, a technical extension again. But with telephones a different kind of information is being dealt with, and in a context where interference by an authority becomes much easier. It is significant in the extreme that years before nationalisation became an issue in other areas it should have taken place so quickly in the telephone service—and under a Conservative government.

Behind the 1869 Telegraphy Act, the 1904 Wireless Telegraphy Act and the 1912 Telephones Act was a growing realisation by the state that the new technologies of both wired and wireless information transmission had military significance and further implications of state surveillance of its citizens.

With radio it was exactly the same. The military got there first—during the First World War. Immediately after that the GPO was busy stopping the early "ham" broadcasts; then, when it was obviously not going to work, restricting their transmission times and wavelengths. The BBC became a device thrown up by the GPO in order to contain in an administratively convenient form the awkward burgeoning desire by the general public for entertainment smattered with enlightenment.

It was the GPO which retained ultimate control. In the first few years of the Company and then the Corporation it did not hesitate to exercise its power forbidding, for example, controversy or political comment of any kind.

At the same time engineering was providing the GPO with control over transmission by land line of the BBC's programmes. It is worth stressing that there is no evidence that GPO engineers ever interfered with programmes so transmitted; that is hardly the point. Moving on 50 years to today, it is via Post Office land lines that a great deal of television output proceeds between studio and transmitter. The same still applies to radio. In both cases the arbiter *could* be the Post Office.

Those of you who follow the story more rapidly than I can write it will have made the connection between the Post Office and the latest information revolution. And, indeed the PO is there already with Prestel: a computer, a television screen and a phone line. Now, at last, the Post Office is actually running the whole show itself.

What am I saying? That information is a vital component of any democratic society; and that its security to individual citizens is a safeguard of the most important order. Only partly.

It seems to me that the *logic* of the GPO when it was a government department, and now as a public corporation, a logic of efficiency and convenience, is probably the true reason why all this has happened. Now, that hardly matters. The danger lies elsewhere. Not from some future dictatorship which would seize everything anyway, but from some nearby further extension of "democratic" state interest in us—all for the sake of information for its files you understand—the Post Office, with its fingers in everyone's private and public information, becomes the means for a truly frightening close control.

George Orwell, in seeing 1948 as 1984, got it wrong when he considered that control meant having a TV camera in every home. Likewise, it is never necessary to tap every phone; we *know* which phones would get tapped, which letters screened, which newspapers deregistered. But why make it easy for anyone to do it? And I would counsel you all to look just across the Channel, to West Germany, to see how a democracy, obsessed with staying that way, can slowly, but inexorably, undermine its citizens' rights by using the battery of methods we have unwittingly, unthinkingly, allowed our friendly Post Office. □

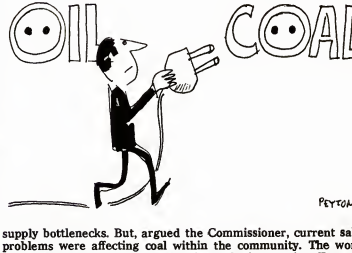
WESTMINSTER SCENE

Energy marketeering

Tam Dalyell MP

As a member of parliament, I do not normally attend conferences. However, on 11 May in Edinburgh, there was rather a special occasion in the Don Room of the City's North British Hotel. Guido Brunner, flanked by the formidable figures of Sir Derek Ezra, chairman of the National Coal Board, and Mr Bob Scoley, managing director of the British Steel Corporation, was summing up the findings of the Consultative Committee of the European Steel and Coal Community held in the Scottish capital.

In uncompromising terms, Dr Brunner, European Commissioner for Energy and Research, spelled out the extent to which the position has changed. No longer can Western Europeans suppose that we can exist in an energy-wasteful society. The queues at petrol pumps which we see on our TV screens are all too likely to come to Britain, as they have already come to Ireland and to Belgium. Little noticed, Japan Airlines has already cancelled 23 international flight routes because of fuel shortages. Dr Brunner emphasised the need for a common policy, since market forces did not take sufficient account of future developments. Short-term patterns of behaviour could lead to dangerous



supply bottlenecks. But, argued the Commissioner, current sales problems were affecting coal within the community. The world coal market would have a growing role in meeting Europe's increasing demand. As he is a German liberal, it was not surprising to hear him say that the more the choice of suppliers was left to consumers, the greater and swifter would be the move away from oil.

I confidently predict that before the new House of Commons is very much older, we will be expressing concern not only about the rise in oil prices, but about problems of delivery and long term scarcity itself. There will be talk of the "energy market" and distinctions between coal, oil, nuclear, and other forms of energy will become blurred. In all the argument, one name among the politicians ought to be remembered—that of Alex Eadie, Minister in the Department of Energy in the outgoing government.

By widespread consent in the House, Alex Eadie (Midlothian) probably knows as much about the coal industry in all its aspects, as any two other MPs put together. A miner before he came to the House, a senior figure in the National Union of Mineworkers, and for five years the minister in day-to-day charge of the coal industry, he has unrivalled experience. It was therefore appropriate and fitting that John Moore, the new Parliamentary Under Secretary at the Department of Energy, should say in answering his first question, "I hope I may be permitted to say how much I recognise the responsibility of following Alex Eadie in his office, after all his work in the coal industry." Moore is obviously—and quite rightly—out to nurture as decent possible personal relations with the NUM, as is possible. Eadie's immediate source of concern was the progress of the two United Kingdom projects involved in the extraction of oil and chemicals from coal. Those projects, in Eadie's estimation, now ranked in importance with the development of the silicon chip, which is why he asked whether Moore would assure the House that in any public expenditure cuts, the oil-from-coal technology would be left untouched. Moore gave an undertaking on behalf of the government that it would support the pilot plant design studies "bearing in mind the vital importance of those developments for our country".

* * *

The singlet of Denis Howell has been assumed by Hector Munro (Dumfries), as Minister of State responsible for sport in the Department of the Environment. He is well-qualified, as a successful former manager of the Scottish Rugby Union side on their tours abroad. However, he is also minister of "Floods and Droughts" and a good deal else. On the top of his in-tray is the question of whether the government is going to reintroduce the Countryside Bill during the present parliamentary session. In reply to the former Environment Minister, Ken Marks (Gorton), Monro said that he was "aware of the interest in many quarters concerning the re-introduction of these provisions. I shall be giving them close attention, among the many urgent matters in my field, both in the light of the needs and of the legislative programme. I cannot anticipate our conclusions". Since the present session is to last 17 months, MPs who served on the Committee Stage of the Labour government's Countryside Bill feel that much of the work should not be wasted as it lacks Party controversy. □

Letters

Radiation risks

Robin Mole states in "Radiation risks—a rejoinder" (10 May, p 440): "It is true that 'ICRP concluded that the ratio of somatic to genetic effects after a given exposure is 60 times greater than was thought 15 years ago'. But the apparent meaning of this statement changes when it is realised that the denominator of the ratio has also changed very considerably. The risk of genetic damage is now regarded as much smaller than used to be thought because of a greatly increased understanding of hereditary effects, especially in the human species."

I would have thought that recent knowledge of the wealth of chromosomal and genetic and, recently, both intergenic and intragenic, variation could only increase the estimated risks of any disruptive activity. It should certainly induce greater humility now that there is known to be more to be ignorant about.

While Dr Mole's belief that the cancer risks are small is consistent with the limited data, any serious deficiency in these estimates will be detected in a decade through the regular channels of industrial compensation. However, the genetic risks are more serious, since our ignorance cannot be remedied by such direct observations in less than a few centuries and the consequences of a germinal error are not contained by a single death.

It is disturbing that after the Three Mile Island incident the US Secretary of Health, Education and Welfare, while accepting a single cancer as a plausible cost, did not even mention those yet unborn (*Science*, vol 204, p 281), although, for reasons which are unclear, pregnant women were advised to leave the area.

The genetic risks may well be sufficiently slight to condone their casual export to the future, but the main effect of recent knowledge has been to extend the penumbra of ignorance and to increase the range of plausibility for both optimists and pessimists, for both friends of the atom and friends of the earth.

J. H. Edwards *Birmingham*

Brickbats

Steven Rose has received more than his fair share of brickbats in recent letters and so in the unlikely event of him being discouraged, may I say how much I, for one, have appreciated his contributions to Forum. Because of the nature of British press ownership, we tend to hear more *of* "the Left" than *from* the Left. This I believe to be an unhealthy feature of our society. Therefore, I think *New Scientist* is to be congratulated for encouraging a regular contribution in Forum from Steven Rose—a practising scientist who has devoted time and energy to examining the complex issues of science and society from a socialist perspective. Part of the continuing attraction of *New Scientist* stems from its willingness to publish a broad spectrum of views.

Harry Rothman
Aston University *Birmingham*

REFERENCES ARE POINTLESS (COURSHEE, NEW SCIENTIST 1974)

Pointless

Are many of your readers so readily irritated as I am by pointless references?

American Scientist, vol 67, p 178, says:

"Scientists are properly cautious of inferring that a relationship is a cause-and-effect one on the basis of an observed association, (Blalock, 1964)."

I have never read Blalock, 1964, but it is probable that the same sentiment was expressed by Pliny, Paracelsus and Shakespeare and possible that it could be equally well attributed to Fu Man Chu and Chu Chin Chow. So why give Mr Blalock the credit?

My own *bête noire* is microclimatology, when so often a modern paper says little more than can be found in an antique text book, Geiger's "The climate of the layer of air near the ground".

R. J. Courshee *Bedford*

To sleep perchance . . .

I write to add to B. D. Josephson's comment (Letters, 14 June, p 940) on an earlier Feedback article on transcendental meditation (TM). Whether his explanation for the apparent benefits of TM despite the inhibition of REM sleep is correct or not, I feel that a piece of evidence of perhaps vital significance has been ignored.

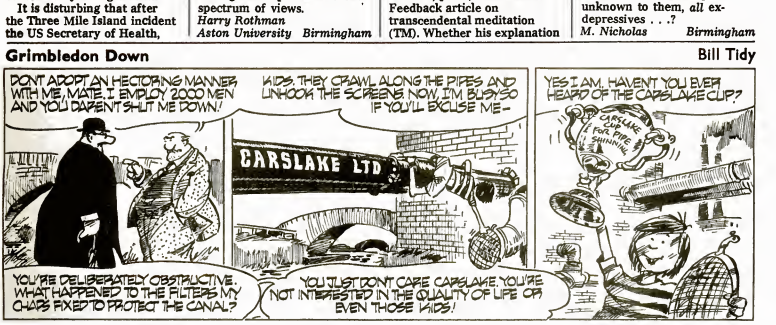
For some time now I have taken an interest in the subject of depression, and have kept a casual eye on the specialist literature. I have noticed quite a body of evidence, particularly from Scandinavian sources, that sleep deprivation is therapeutic for some victims of this illness. Reading further, I find that the same therapeutic effect can be obtained by depriving the subject of REM sleep alone. Indeed, the main effect of many anti-depressant drugs, and, of course, of the dreaded ECT, is to reduce the amount of REM sleep. Unfortunately, researchers have not yet revealed, as far as I can discover, why a reduction in REM sleep should be therapeutic in certain types of depression, and indeed researchers seem reluctant to theorise.

How is this relevant to the study of TM? Is TM, which reduces the amount of REM sleep, to be seen as a cure for depression? After all, if one's need of something is lessened, then surely the effect of depriving one of it will be lessened also. Will only depressives benefit from TM, since, as far as I know, they are the only group of people shown to have benefited from a lack of REM sleep? Are those who proclaim the benefits of TM, perhaps, unknown to them, *all* ex-depressives . . .?

M. Nicholas *Birmingham*

Grimbledon Down

Bill Tidy



-ENIGMA-

No. 19

High places

Martin Hollis

"Cheer up!" said Professor Plato to the four students huddled in the bar, awaiting the results of their logic exam, "It was a large field and the positions which you four gained add up to an honourably small total of 16. In fact the examiners placed you four in alphabetical order. Their list, by the way, included no ties. Now I shall tell each of your his own position privately."

This he did and, when the quartet had absorbed and imbibed, he continued, "Well, I wonder if anyone can deduce the positions of all the other three. Amble, you first, as you finished ahead of the others."

"Not I," said Amble. "Nor I," said Bumble. "Nor I," said Crumble. "Nor I," said Dimwit. "Nor I," said Amble again. "Nor I," repeated Bumble.

They were all right about that, even assuming each had made all possible deductions before he spoke. Given that Crumble actually finished two places above Dimwit, can you work out all four positions?

A £5 book token will be awarded to the sender of the first correct solution opened on Wednesday, 4 July. Please send entries to New Scientist, *King's Reach Tower, Stamford Street, London SE1 9LS, marking the envelope* Enigma. *The editor's decision is final. The winner of Enigma No 17, Squares and Rectangles, was Mary Gregory from Stafford.*

Answer to Enigma 18

Football, old method

A v B	0-1	*B v C*	0-1
A v C	1-3	*C v D*	0-3

Heat pumps

Your item on heat pumps (Technology, 31 May, p 727) suggests another area for development to which many of us concerned with Third World countries would accord high priority—that is, reverse heat pumps as used in air conditioning or refrigerated storage facilities.

One of the most widespread innovations in virtually all large cities in the Third World over the past 20 years has been the air-conditioned office block. Such a building has its virtues: it is undoubtedly pleasanter to work in than buildings cooled by natural or forced ventilation. But it has serious disadvantages.

Apart from social costs—the way in which those working in such buildings are cut off from the mass of people outside—air-conditioned blocks have two major snags. First, they are heavy consumers of electricity—dependent in most countries on increasingly expensive imported oil. Secondly, if there is a power failure, the building becomes unbearable, since it is not designed to make use of natural ventilation.

The social costs are probably inescapable in the absence of major changes in social and political structures. But the other disadvantages could be surmounted by the development of solar-powered self-contained air-conditioning systems. Indeed, I understand that buildings using solar power in this way have been constructed in the United States. But so far the systems are very expensive, mainly I suspect, because they are one-off jobs. There is no reason in principle why standard designs for mass-produced systems could not be developed whose capital cost was not greater than that of existing air-conditioned buildings.

Such solar-powered reverse heat pumps, if their costs could be reduced, would also be a major asset in the expansion of rural cold-storage facilities, by making them independent of electricity or oil supplies.

One would like to see such devices developed in Britain although our climate is such that the domestic demand would be limited. But we could at the least cooperate with other countries—and in particular with Third World countries—in the development of commercially viable systems.

Percy Selwyn
Institute of Development Studies *Sussex*

Mad chemistry

I write to question whether reducing mental illness to "aberrations of biochemistry" is as useful as Donald Gould and the Schizophrenia Association—and many others too—suggest in "Molecules and Madness," (31 May, p 720). The "internal chemical dysfunction" theory is superficially attractive, but has two fatal philosophical flaws, aside from the lowering of the dignity and worth of the sufferer which results from it.

First, because the brain is in such close touch with the outside world, events there will alter its chemistry. The step to seeing that events—as (mis)interpreted by the patient, of course—may initiate or contribute to chemical changes, which we interpret as mental illness, is a straightforward one.

Secondly, and more importantly, even this view is not adequate. Strict materialism is forced to reject the notions of "truth" and "falsity" as nonsensical, for reasons too well-rehearsed and too long-winded to discuss here.

Now, though there is little agreement on what symptoms all schizophrenics share, one of them is that their view of reality is distorted, that is, false. Thus the materialist position denies the existence of schizophrenia, and is consequently self-defeating. (Unless one were to take the cynical view that some people need therapy because they upset us.)

Of course, such materialism is far better than "beating lunatics with chains"; and of course I do not suggest that we cease to give schizophrenics their one-a-day phenothiazines. Research such as Dr Crow's should continue; but he may agree that external factors change people's susceptibility to his presumably widespread virus.

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Letters

continued

I conclude by trying to clarify my position. I have such sympathy for Mrs Hemmings and her husband; but I fear she is mistaken to insist that mental illness is purely somatic in nature—in fact I think this view is a curse in disguise. I have no sympathy whatever with people who stigmatise either the mentally ill, or their relatives: indeed, I find such behaviour sick and cruel, for it makes a horrible situation still worse.

Mental illness, like all biology, is not black/white: the causes of illness are neither all environmental nor all internal, and either position can be flogged to death. Consequently we should not deny that schizophrenics are likely to have disturbed brain chemistry, not that their environments are likely to be unusual. Perhaps we should not risk our necks by claiming that either is the cause of the other—for we need a concerted attack (drugs as well as therapy) if we are to cure people.

J. C. Tucker *Bristol*

Gamma bursts

It was interesting to read John Gribbin's account of current developments in gamma ray astronomy (14 June, p 920).

Several γ-ray bursts with lifetimes < 1 μsec are recorded each year, and no adequate explanation of these bursts has been forthcoming. I suggests some γ-bursts may be artificial in origin produced by alien civilisations.

Take for example, a laser operating at a wavelength of 10^{-10} metres. If the laser has an effective diameter of 1 metre, the theoretical beam width is 5×10^{-8} seconds of arc. Converting to solid angles and allowing our aliens to be less than perfect this laser would have to operate at $\geq 10^{-18}$ watts to match the radiant power of a mini-black hole. The laser frequency is 3×10^{18} Hz. Assuming a 1 per cent modulation bandwidth, 0·25 μsec of transmission is equivalent in terms of data to an hour of video transmission in the UHF region of the spectrum. I do not suggest that extraterrestrial γ-lasers are being aimed at the Earth, merely that on occasion the Earth intercepts a γ-laser transmission. This implies a very large number of such transmissions.

T. D. Clark *Brighton*

Peak performance

Wretched and unfit volunteers forced to run up little mountains in the interests of science may well develop oedemas (Monitor, 14 June, p 915). But I doubt if they have real mountain sickness.

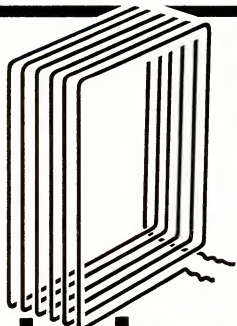
Altitude surely plays the most important role in triggering off mountain sickness, and from my own casual observations the correlation between mountain sickness and altitude is simply too close to be otherwise.

In mountaineering, there is no cure for mountain sickness other than descent. Two years ago a friend was stranded half way up the Matterhorn with mountain sickness. We kept him warm throughout the night, and he certainly was at rest for several hours until dawn. By daybreak, though, he was still visibly ill, and only by descending some 1000 metres was he restored to an approximation of his usual cheery self.

Drs Williams and Ward need only canvass for climbers' tales at any mountaineers' watering hole (try the Bar National at Chamonix!) to hear countless similar anecdotes.

There seems, incidentally, to be comparatively little obvious correlation between levels of physical fitness and susceptibility to mountain sickness.

William Leece *Liverpool*



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APPOINTMENTS AND SITUATIONS VACANT

LONDON MARINE TECHNOLOGY CENTRE
Department of Mechanical Engineering
University College London
RESEARCH IN THE DYNAMICS OF OFFSHORE STRUCTURES

Applications invited for Research Assistantships in the SRC supported London Marine Technology Centre within the University. The Centre specialises in research into the structural, material and dynamic aspects of the design of offshore structures. Vacancies exist on projects investigating the dynamic response of floating vessels to sea excitation. Projects involve both simulation and experimental model testing using the Centre's extensive range of computing and wave tank testing facilities. Applicants should have a degree in Engineering with some postgraduate qualifications or experience although candidates who have just completed a first degree may also be considered. Posts offer an ideal opportunity to develop specialised expertise in the engineering and design of offshore structures. Salary, depending on qualifications and experience, in range £3,717 to £6,368 p.a. plus £502 London Allowance. Applications and requests for further information to Departmental Secretary (MP), Dept. of Mechanical Engineering, University College London, Torrington Place, London WC1E 7JF.

UNIVERSITY OF MANCHESTER
Department of Chemistry and Artificial Kidney Unit, Withington Hospital
RESEARCH FELLOW

Applications invited from postdoctoral analytical chemists with a strong interest in medical research for a joint medical/chemical research programme on trace metal uptake through artificial kidney machines. The work will involve chemical analysis of aqueous and clinical samples for trace metals, by flameless A.A.S., and fundamental research into metal ion transfer across dialysis membranes; it will demand a high level of scientific ability. Experience of similar work is desirable. Starting salary in the range £4,333 to £5,969 p.a. Superannuation. Contract period 2 years, starting as soon as possible. Further details from Dr. J. P. Day, Department of Chemistry, University of Manchester M13 9PL (phone 061-273 7121 ext. 5374), to whom applications with full curriculum vitae should be sent as soon as possible.

GUY'S HOSPITAL MEDICAL SCHOOL
TWO ASSISTANTS

— preferably Graduates with computer programming experience — required for one year for a research project into back pain in the Department of Community Medicine, which will include interviewing patients. Full-time workers preferred. Salary according to qualifications and experience. Applications, stating age and giving details of qualifications and experience, to the Secretary, Guy's Hospital Medical School, London Bridge, SE1 9RT, quoting Ref. CM3.

Wellcome

Senior Technicians

The Wellcome Research Laboratories at Beckenham manufacture vaccines and diagnostic products for human and veterinary diseases, and markets them on a world-wide scale. We have the following opportunities:

Senior Technician
Quality Control — Identifying contaminant organisms

A Senior Technician is required to work with the scientist in charge of the section, and be responsible for the routine work of the section, including two technicians. The work involves identifying contaminants discovered when sterility tests are carried out, and tracking down their source.
Applicants should be qualified to HNC level, and have several years' appropriate experience, preferably including knowledge of Q.C. procedures. Salary scale £4,084-£5,476.

Senior Technician
Production — Diagnostics

Many of our wide (and developing) range of medical diagnostics are presented in freeze-dried form, Running our freeze-drying unit requires experience of dealing with people, and ability to organise differing quantities through machines of different capacity, keep them all fully occupied, and plan the output of our filling machines and staff to match the freeze-drying capacity, and the production schedule. In fact, a production manager's of finished products.
You will need sufficient biological knowledge to appreciate what is happening, and what is required, and a practical attitude to understand the engineering aspects of freeze-drying. This unusual job demands a person of wide abilities with the capacity to grow with the job, as the Wellcome Reagents organisation continues its rapid rate of growth. Salary scale from £5,153 rising to £6,913.
The Laboratories are situated in pleasant parkland surroundings within easy reach of Central London. Conditions of employment are excellent and include subsidised canteen, pension scheme, 4 weeks' holiday, generous relocation expenses where appropriate, and sports and social facilities.

Please write, with details of relevant experience and qualifications, to:
R. V. Sutton,
Personnel Officer,
The Wellcome Research Laboratories,
Langley Court,
Beckenham,
Kent BR3 3BS,
quoting reference no. AQ/48.

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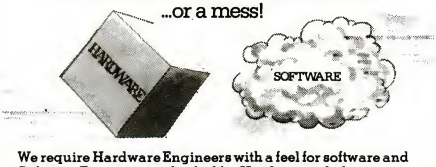
The collision about to take place can result in a flexible and powerful system...

...or a mess!



We require Hardware Engineers with a feel for software and Software Engineers with a feel for Hardware to help Burroughs continue their tradition of successfully merging the most up-to-date LSI technology with advanced system software techniques to create a highly successful range of business systems.

If you have a Degree plus 1-3 years experience of working near to the Hardware - Software interface, we'd like to meet you.

Contact Paul Dunachie, Graduate Recruitment Manager, Burroughs, Cumbernauld G68 0BN. 023-673 5457 day 041-942 5599 eve.

Burroughs

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Start your career in the right direction!

Exciting job opportunities are available to you *now*, in the field of your choice. We can guide you in the right direction for further details contact

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The experts in Scientific & Technical Recruitment

UNIVERSITY OF RHODESIA

LECTURESHIPS/ SENIOR LECTURESHIPS

Applications are invited for the following posts:

BOTANY: Applicants must have a relevant first degree and, preferably, a postgraduate qualification and relevant experience. Competence in one or more of the following fields will be advantageous: Anatomy and Morphology; Microbiology and Plant Physiology.

CHEMISTRY: The Department has lectureship vacancies in Physical and in Inorganic Chemistry. Applicants must be suitably qualified with university or research experience. In addition the Department has responsibility for courses in Pharmaceutical Chemistry for B. Pharmacy degree students and, therefore, special interests or experience in pharmaceutical or medical applications of Chemistry would be an advantage.

COMPUTING SCIENCE: Applicants must have qualifications and experience in Computing Science. A knowledge of statistical methods will be an advantage.

CROP SCIENCE — SCHOOL OF AGRICULTURE: Applicants must have a relevant first degree and, preferably, an appropriate higher degree and relevant experience in Crop Science.

ELECTRICAL AND MECHANICAL ENGINEERING: Applications are invited from persons with Engineering Degrees and postgraduate experience for Lectureship posts in: (a) the Department of Electronic and Power Engineering (experience desirable in Electronic Power Systems, Electrical Machines and Electromagnetics); (b) the Department of Mechanical Engineering (Experience desirable in Thermodynamics, Heat Transfer and Mechanical Design).
Subject to University permission earnings up to a specified limit per annum for consultancy may be retained in full in addition to basic salary.

ZOOLOGY: Applicants must have a relevant first degree. A higher degree and postgraduate experience is desirable. Preference may be given to applicants with competence in one or more of the following fields: Vertebrate Zoology; Terrestrial Ecology; Genetics and Parasitology.

SALARY SCALES AND CONDITIONS OF SERVICE
Salary (Approx. Stg. Equiv.):-
Senior Lecturer £7,088 x 275 - £7,913 x 292 £9,373 p.a.
Lecturer Grade I £6,429 x 242 - £7,397 p.a.
Lecturer Grade II £3,989 x 208 - £5,009 x 242 £6,219 p.a.

Commencing salary according to qualifications and experience. Family passages and allowances for transport of effects. Installation Grant and Installation Loan. Sabbatical Leave and Contact Visits; Superannuation and Medical Aid Schemes. For persons recruited from outside Zimbabwe-Rhodesia, unfurnished accommodation on or near the Campus and close to good junior and senior schools, is guaranteed for up to three years.

Appointments may be on permanent pensionable terms or for a fixed term of 1 or 2 years in the first instance. In the case of 1 or 2 year contracts a non-pensionable salary is payable on the above scales plus a 10% supplement.

At present, immigrants and persons on temporary contract, are exempted from military service for two years from the date of their arrival in Zimbabwe-Rhodesia.

Further particulars and details of application procedure may be obtained from the Association of Commonwealth Universities (Appts), 36 Gordon Square, London WC1H 0PF.

Closing date for the receipt of applications: 18 July 1979.

The University's Charter provides that no test of religious belief or of race, nationality or class shall be imposed upon or required of any person in order to entitle him to be admitted as a member, professor, teacher or student of the University or to hold office therein or any advantage or privilege thereof. British subjects considering applying for posts in Rhodesia are urged to consult the Foreign and Commonwealth Office (telephone 01-233 8727) or their nearest British Consular Office.

Allied Medical Group

Management Consultants to the

Riyadh & Al-Kharj Hospital Programme Riyadh, Saudi Arabia

HEAD OF MEDICAL PHYSICS AND BIO-ENGINEERING

The Riyadh and Al Kharj Hospital Programme is a newly established organisation with the objective of providing health care of the highest quality to the Armed Forces of Saudi Arabia.

The Programme is rapidly expanding and accordingly requires as a first appointment a Head for the newly erected Department of Medical Physics and Bio-Engineering. The appointee will have Senior Consultant status and will be responsible to the Programme Director through the Medical Staff Executive Committee (of which the appointee will be a member) for the development and organisation of Medical Physics and the provision of support to the Departments of Radiotherapy, Diagnostic Radiology including Nuclear Medicine, Ultra sound and CTR scanning, and the departments engaged in Clinical Measurement and for the organisation and staffing of the Radio Pharmacy.

Since this is the first appointment the appointee will clearly have a wide margin of discretion in the appointment of subordinate staff.

Applicants should have a minimum of three years broadly based experience at the Principal grade and shall possess a post graduate degree in addition to a good class honours primary qualification.

Candidates wishing to discuss the post are invited to contact Allied Medical Group's Specialist Adviser:

Professor S. C. Lillicrap
Wiltshire Area Medical Physics Department,
Royal United Hospital,
Combe Park,
Bath, Avon.
Tel: 0225-28331 Ext 865

Terms and Conditions

Salary:
205,504 Saudi Riyals per annum (7 SR = £1 approx).

Bonus:
An additional month's salary for each completed year of service at end of contract.

Travel and Leave:
First class travel and four weeks leave after each 26 week period of satisfactory service.

Income Tax:
There is no income tax and no currency exchange/ transfer restrictions in the Kingdom.

Accommodation:
Free accommodation, recreation, welfare and transport.

Medical Care:
Free for all accompanying dependants.

Educational Allowance:
Payable to agreed dependants.

If you have a definite interest in the post after discussion with Professor Lillicrap please contact our Personnel Director in London:

Mr. Russell Davies,
Allied Medical Group,
18 Grosvenor Gardens,
London SW1W 0DZ.

or telephone: 01-730 4511

I look forward to meeting you.

Dr. J. Muir M.D., F.R.C.P.
Medical Director Allied Medical Group, Riyadh.

AMG

Allied Medical Group

unilever research

Science/Social Science - Toiletries Research

An unusual and challenging vacancy exists for an Assistant Scientist to join a team working on human responses to toilet preparations. Consumer tests, clinical trials and habits studies currently give rise to large banks of data which are then analysed to give information regarding product performance and consumer preference. We now wish to recruit a specialist to use the data synthetically and hence make discoveries regarding the interaction of, say, habits and performance.

The successful candidate will have a background in science or social science to degree level, but numeracy will be the prime requirement. He/she will be required to collaborate with physical and behavioural scientists on the one hand and computer technologists on the other.

The post will be at the Unilever Research Laboratory, Port Sunlight which is situated on the Wirral peninsula within a few miles of the sea and within easy reach of Chester, North Wales and Birkenhead. Initially the successful applicant will be seconded for job training purposes to Unilever Research Isleworth, Middlesex until October 1979.

The company operates a progressive salary policy together with a contributory Pension Scheme, Sickness Benefit Scheme and other fringe benefits. Starting salary will be from £3,650 dependent upon relevance of experience.

Further information and application form may be obtained from

The Employment Officer,
Unilever Research Laboratory,
Port Sunlight,
Bromborough, Merseyside.
Telephone: 051-645 2000, Ext. 8408.

quoting Ref. No. PS 666AS.

McVITIE'S K.P. FOODS KEEBLER (U.S.A.)

WIMPY

United Biscuits, one of the leading food groups in the world with a turnover in excess of £700m and operating principally in the UK and USA have the following vacancies:-

Assistant Scientist

The successful candidate will be responsible for developing methods for the determination of biscuit flour specification and will be based at our new Research and Development Centre at Maidenhead. Applicants should hold a Good Honours Degree in Food Science or Chemistry and have had approximately 2 years practical experience of food analysis.

Microbiologist

The successful candidate will be required to assist the laboratory section manager in providing an efficient microbiological service to the Research and Development Centre at Maidenhead at which he/she will be based. Will also be required to supervise a small team of scientific staff allocated to him/her. Applicants should hold a Good Honours Degree in Microbiology or a related science and have had a minimum of 3 years practical experience of the microbiological testing of foods.

Benefits include good salary, over 4 weeks holiday, generous pension scheme, staff shop, car parking, etc.

Please write or telephone for an application form to: Miss P. Jung, Personnel Manager, United Biscuits (UK) Limited, Syon Lane, Isleworth, Middlesex, TW7 5NN. Tel: 01-560 3131.

MACFARLANE LANG

United Biscuits (UK) Limited

CRAWFORDS CARRS

IMPERIAL COLLEGE
UNIVERSITY OF LONDON

Department of Chemical Engineering and Chemical Technology

Applications are invited for the following position: Research Officer to work with the materials technology research group under the direction of Professor J. R. A. Pearson. The group is engaged in experimental and theoretical work on Polymer Chain Dynamics (using relaxation, light scattering and computer simulation methods), Polymer Rheology, Polymerisation Reactors and Polymer Processing operations. Applicants should have a PhD in physical chemistry, physics or chemical engineering, previous experience with polymers being an advantage. Initial salary in range £4,250-£7,145 p.a. plus £502 London allowance.
All applications, including a curriculum vitae and the names of two referees, should be sent to: Dr K. E. Bett, Department of Chemical Engineering, Imperial College, London SW7 2BY.

UNIVERSITY OF HULL
Department of Applied Physics
RESEARCH ASSISTANTSHIP — NON DESTRUCTIVE TESTING

Applications are invited for a research assistantship tenable for a period of up to two years in the first instance with the possibility of renewal. The research assistant will be involved in the study of magnetic particle inspection testing and ultrasonic testing of a wide variety of industrial components, in collaboration with the Health and Safety Executive, Nuclear Inspectorate.

Applicants with a good honours degree in Physics, Applied Physics or Materials Science will be considered but relevant postgraduate experience would be an advantage.

Salary will be on the scale £3,775-£5,488 per annum (from 1 October) together with USS benefits. Applications, which should include the names of two referees, should be sent as soon as possible to Dr. S. B. Palmer, Department of Applied Physics, University of Hull, Hull, HU6 7RX, from whom further particulars may be obtained.

MEDICAL RESEARCH COUNCIL
RADIOBIOLOGY UNIT

CYTOGENETICS

A vacancy exists for a scientist to work in a group investigating the effects of ionizing radiation upon chromosomes in a variety of cells and tissues.
Applicants should have a good honours degree, and at least 3 years post-graduate research experience. They should be conversant with modern cytogenetic techniques and some knowledge of tissue culture is desirable. Usual Medical Research Council conditions of service. Salary according to age and qualifications. Applications in writing to: The Administrator, M.R.C. Radiobiology Unit, Harwell, Didcot, OXON OX11 0RD quoting reference JRKS/1.

TECHNICIAN (Grade 3)
required in Chemistry Department, University of Reading, mainly to assist technician in charge of Physical Chemistry Laboratory in preparing the lab. for undergraduate classes and giving a service to undergraduates during classes. Training in assistance to research groups in Physical Chemistry will be given. ONC, SLT or equivalent qualification desirable. Apply with names of 2 referees and full details, quoting Ref. TS.45A, to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH.

SEAN MacHALE AND ASSOCIATES – BUSINESS CONSULTANTS

Animal Food Technologist

Sean MacHale & Associates have been retained by a well known company, engaged in food processing, animal feed production and allied products, to recruit a suitably qualified graduate for the above position.

The successful candidate will preferably have a qualification in animal science (production) with special emphasis on ruminant and pig nutrition. He/she will join a team already engaged in product development and will have at least 3 years experience in developing animal food products from the initial concept right through to the completed market product.

A good working knowledge of the animal food market and the latest developments in this area, with the ability to assess same, is a definite requirement for the position.

This position offers an excellent opportunity for career development to a person with the capacity to respond to a creative environment. A very attractive salary, with excellent working conditions, plus the normal fringe benefits that apply for this level of appointment.

Re-location expenses where appropriate.

Contact P. J. Feeney, Personnel Advisor to the company, quoting Reference No. 520/16.

Sean MacHale and Associates,
Personnel Services and Recruitment Division,
46 Lower Leeson Street,
Dublin 2, Ireland. Telephone: Dublin 68 82 95/68 89 91.

THE NATIONAL HOSPITALS FOR NERVOUS DISEASES
QUEEN SQUARE, LONDON WC1N 3BG

require a

JUNIOR MEDICAL LABORATORY SCIENTIFIC OFFICER

to undertake duties In routine chemical pathology. Applicants should possess 5 O'levels including one science subject, English Language and Mathematics.

Facilities are available for further study.

Salary, which is dependent upon age and qualifications, is on the scale £2,259-£3,369 (inclusive of London Weighting Allowance).

Applications should be make in writing, giving details of experience and qualifications, and quoting the names and addresses of two referees to the Personnel Department at the above address, tel. no. 837 3611 ex. 65.

KING'S COLLEGE HOSPITAL MEDICAL SCHOOL
(University of London)
Denmark Hill, London, SE1 8RX

JUNIOR MEDICAL LABORATORY SCIENTIFIC OFFICER 'B'

required for the Chest Unit in this Medical School. Work will involve contact with patients and assisting doctors with research into diseases of the lung.

Minimum requirements, 5 'O' levels, 4 in Science subjects including maths, day release available. Post Suitable for school leaver.

Salary according to age, qualifications and experience.

Applications, in writing, giving full details should be sent to the Secretary of the Medical School at the above address. Closing date, 13th July, 1979.

BRIDGE CHEMICALS
Section Head
Chemical Development

Bridge Chemicals Limited is the UK Manufacturing and Chemical Development facility of the Chemicals Division of the SmithKline Corporation, a leading international pharmaceutical company, and is based at Tonbridge, Kent.

Due to expansion in our chemical development programme, we require a Section Head to lead a team of graduate chemists working in the Chemical Development Department.

The work of the group, which is directed towards the development of commercially viable processes for novel therapeutic agents, involves the scale up to Pilot Plant, transfer of processes to production facilities worldwide and the search for new synthetic sequences.

Suitable candidates will probably be in their mid to late 30's with a PhD in Organic Chemistry and at least three years post doctoral experience in the Fine Chemicals industry. They must be able to accept responsibility and be interested in seeing their creativity reflected in commercial chemical processes.

The salary offered will reflect the high quality of the person we are seeking and should be in the range £7,500-£9,500. In addition, we offer a discretionary annual bonus, free life assurance, an excellent contributory pension scheme and flexible working hours. Assistance will be given with removal expenses where appropriate.

Please send full curriculum vitae, quoting reference BD 9/4 to:
Mrs. P.D. Whitton, Personnel Administrator,
Bridge Chemicals Limited, Old Powder Mills, Nr. Leigh,
Hildenborough, Kent TN11 9AN.

a SmithKline company

PLANT BREEDING INSTITUTE
Maris Lane, Trumpington, Cambridge, CB2 2LQ

HIGHER SCIENTIFIC OFFICER/ SENIOR SCIENTIFIC OFFICER
CYTOGENETICS DEPARTMENT

A research worker with experience in plant cytogenetics/cell biology is required for three years to participate in and be responsible for parts of a programme funded by the Ministry of Overseas Development to study the cytogenetics and cell biology of endosperm development and grain quality in cereals with special attention to grain shrivelling in wheat-rye genotypes including triticale.

Candidates should have a 1st or upper 2nd class honours degree in an appropriate biological science and at least two years postgraduate experience in plant cytogenetics/cell biology or related research.

The appointment will be as Higher Scientific Officer (£4,101-£5,448 per annum) or Senior Scientific Officer (£5,154/-£6,988 per annum). At least four years relevant postgraduate experience is required for appointment as Senior Scientific Officer.

Applications with curriculum vitae and names and addresses of three referees should be sent to the Assistant Secretary (Establishment), quoting reference ODM/47, by 27 July 1978.

MECHANICAL WORKSHOP TECHNICIAN (Grade 4)

required in Department of Psychology, University of Reading. Varied work involving design and construction of apparatus for experiments carried out by students and academic staff. ONC, C & G, or recognised apprenticeship essential, with around 5 years experience in use of machine tools, e.g. lathe and milling machine, working to normal workshop tolerances. Salary in scale £3,222-£3,708 p.a. Further details available from Dr. B. Moulden, Department of Psychology. Apply with names of two referees and full details, quoting Ref. TS.46A, to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading, RG6 2AH.

Microbial Biochemist for Fermentation Development

The Fermentation Development Department based at the Worthing site is concerned with the development of fermentation and enzymatic processes for the production of antibiotics and related substances. As a result of proposed expansion, a Microbial Biochemist is required to join a multi-disciplinary team working on all aspects of industrial fermentation processes.

Applicants should possess a good honours degree in Biochemistry or Microbiology preferably with some post-graduate experience. The position requires an innovative approach combined with an ability to organise the work of one or two technical assistants.

The normal large company benefits will apply, and if you are interested you should write to, or telephone, Mr A D Caws, Senior Personnel Officer, Beecham Pharmaceuticals, Clarendon Road, Worthing, West Sussex, BN14 8QH — Telephone (0903) 39900, Extension 233 — for an application form.

Beecham Pharmaceuticals

UNIVERSITY OF EXETER
LECTURER IN COMPUTER SCIENCE

Applications are invited for a lectureship in the Department of Computer Science, tenable from 1 October 1979.

Candidates should be qualified persons working in any area of computer science. Specialisations which are of particular interest, but which are not intended to make up an exhaustive list, are: data-base computation and theory; artificial intelligence; computer architecture and systems; theory of programming languages and semantics; operating systems; distributed computing and networks.

Commencing salary will be within the range £4,232-£6,368 p.a. (under review) on the scale £4,232-£8,452 p.a. (under review). The post is subject to a probationary period not exceeding three years with the prospects of permanency thereafter.

Further particulars may be obtained from Miss Doreen Watson, University of Exeter, Northcote House, Exeter, EX4 4QJ, to whom applications (8 copies) should be forwarded by 23 July 1979. Please quote reference No. 3216.

People who have applied for a similar post earlier this year will be automatically considered for this present post.

Further information may be obtained from Professor J. A. Campbell, Department of Computer Science (Ext. 216).

Royal National Institute For The Blind

ASSISTANT TECHNICAL OFFICER

Design Engineer, age 30-45, having Degree, Diploma or equivalent, for work on design of devices to aid blind people and development of processes and machines for producing braille. Some years practical and drawing office experience in field of light mechanical and electro-mechanical design, prototype development and follow-through to manufacture required. Knowledge of machine control techniques advantageous. Ability to produce accurate verbal and written reports essential. Salary £5733 — £6069 p.a. (review July). Free lunch in staff restaurant. Excellent pension scheme. Applications in writing to: Personnel Officer, 224 Great Portland Street, London, W1N 6AA.

UNIVERSITY OF CAMBRIDGE
Department of Biochemistry
TECHNICIAN GRADE R6

required to work with the Protein Synthesis Group on an MRC sponsored project for 2 years to study the integration of the control pathways regulating the initiation of protein synthesis in mammalian cells. The duties of the post include general laboratory maintenance and assistance with experiments. Previous experience in a biochemical or cell biology laboratory would be an advantage.

Salary on scale £3,220-£3,716 per annum. Support for this post terminates in October 1981.

Further details can be obtained from Dr. R. J. Jaekson, Department of Biochemistry, Tennis Court Road, Cambridge CB2 1QW.

CAPITAL APPTS.

FORTRAN

Programmers and Analysts urgently required. We are the specialists in Scientific and Engineering applications
£2500- £9000
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At our U.K. Research Centre, situated near Camberley in Surrey, we are actively engaged in besic research and development on a variety of projects.

Recent expansion of our Agricultural Formuletion Group plus reorganisation in other areas means we have a number of interesting opportunities for science graduates.

Agricultural Formulation

Three graduate chemists are required to work on our pesticide formulation development progremmes from leboretory to Initiel production levels. Experience in aqueous suspension type formulations would be very useful, but equal consideretion will be given to greduates wishing to move into this type of development work.

Quality Assurance/Technical Services

A new or recently qualified pharmacist or chemist is required to join a team invoived in all aspects of Quality Assurance and Technical Services work with our Affiliates and contract manufacturers throughout Europe, Middle East end N. Africa. We shall be looking for an energetic and enquiring mind together with good problem solving skills. Quality Assurance experience is not essential es full training will be given. Some foreign travel will be involved.

Analytical Chemists

To work on the development of analytical methodology for the progression of drug substances to ciinicel trial stage. The projects involved ere very varied and require a sound working knowledge of modern analytical methods especially in the areas of H.P.L.C.: G.L.C. and mass spectroscopic techniques.

Development Chemist - Stability Testing Organiser

For a new or recently qualified graduate chemist this is an interesting opportunity to help organise the stability testing of pharmaceutical, agricultural and veterinary formulations. Although experience is not necessary a basic grounding in statistics and computer science would be very valuable. The work involves the compilation of stability test data and the subsequent discussion of analytical results; improvement of existing methods and the review of data for regulatory requirements.

For all of these positions a highly competitive salary is offered together with a non-contributory pension and life assurance scheme, four weeks holiday, subsidised B.U.P.A. and relocation expenses where applicable.

Please write with brief career details to: Martin Neville, Personnel Maneger,

LILLY RESEARCH CENTRE LIMITED
ERL WOOD MANOR, WINDLESHAM, SURREY. TEL: (0276) 73631.

Development Technologist

N.W. Essex

The company is a multi-million, internationally known manufacturer of telecommunications and electronics equipment and is in the forefront of new technology in these fields. As centrally directed unit has established to concentrate on a major product design programme involving voice, data, text and graphic information. This has lead to an urgent need for a development technologist who will play an active roll in the development of emerging technologies for new products.

Candidates should be aged between 25/30 and are expected to be qualified to degree or HNC level in applied physics, Electronics or other appropriate discipline and a minimum of 2 years experience in a product development environment.

The rewards include a negotiable salary to £5,000, generous relocation allowances were appropriate and an attractive superannuation scheme.

Telephone or write to: Gordon Dawson, PER Cater House, 49 High Street, Chelmsford, Essex. Chelmsford (0245) 60234.

PER Professional & Executive Recruitment

Applications are welcome from both men and women

STAFF WRITER

Required for ELECTRONICS & POWER, the IEE's monthly magazine for the professional electronics and electrical engineer. He or she will initiate, research and write authoritative full-length articles and shorter comments and features for this leading technological magazine.

A professional scientific or engineering qualification to degree standard and appropriate industrial background are highly desirable, but more important is the ability to write crisply and clearly on a wide range of topics of technical and professional interest to IEE members.

The post is based at Stevenage, but applicants should be prepared to travel thoughout the UK and occasionally overseas. The preferred age range is 25-35, and a realistic and competitive salary will be paid to the successful applicant.

We offer modern office accommodation, flexible working hours, five weeks' annual leave, contributory pension scheme, luncheon vouchers and subsidised staff restaurant.

Please write with sufficient details to:

J D St Aubyn
Editor in Chief
THE INSTITUTION OF ELECTRICAL ENGINEERS
Southgate House
Stevenage, Herts. SG1 1HQ.

IEE

4080

The hottest number in software support

Among computers designed for real-time applications, the GEC 4080 is acquiring something of a star reputation. In our opinion, that reputation is wholly justified. We should know – we've just invested over £1 million on six 4080's to form the basis of a new internal bureau. The installation has a total of 50 terminals, and provides all the back-up needed by a large-scale software engineering group, working on highly advanced real-time applications.

To maintain and extend the services we offer our "Customer," we now need a number of men and women – at team leader, and more junior levels – to maintain, develop and up-date the systems software, with particular emphasis on its integrity.

You'd also be involved in the development of new systems software such as utilities, macros and libraries.

For the team leader's role, you'll need at least three years' relevant experience; for the other roles, less experience is acceptable. Experience with GEC Series 4000 computers will obviously be an advantage.

If you like the idea of software support in a real-time scientific environment, Chris Hill can tell you all you need to know – and fix up a time for an interview.

Why don't you phone him on 01-953 2030, extension 3449.

Alternatively, write to him at Marconi Avionics Ltd., Elstree Way, Borehamwood, Herts.

Please quote ref. MA 79103.

MARCONI AVIONICS

A GEC-Marconi Electronics Company

Department of Applied Science

Technician T2

To assist in the general running of a Physics Laboratory at Barking and to work with the Gas Counter Research Group at West Ham. An interest in electronic and/or vacuum systems is desirable.

The inclusive annual salary will be on a scale from £3,564 to £3,936 according to age, qualifications and experience.

For further details and an application form please contact the Personnel Office, North East London Polytechnic, 109 The Grove, Stratford. E15. Telephone 555 0611 ext 32 quoting reference number T75/79. Closing date: July 6, 1979.

NELP

UNIVERSITY OF LONDON
Institute of Psychiatry
STATISTICIAN WITH KNOWLEDGE OF PROGRAMMING — FULL TIME

A full time statistician is required to join a multidisciplinary research team of psychiatrists, sociologists, research and social workers currently investigating psychosocial aspects of primary health care.

He/she will take part in design of research and discussion of current research problems, advise on methods of analysis, analyse data and run the computing involved. Knowledge of Fortran programming is essential. Preference will be given to applicants with post-graduate statistical training.

Starting salary will be in the range £4,232-£7,145 plus £502 London allowance, (Lecturers' Scale Grade 1A), according to qualifications and experience. Starting date September 1st 1979.

Application forms from The Secretary, Institute of Psychiatry, De Crespigny Park, Denmark Hill, London SE5 8AF quoting ref: AC/NS.

PEOPLE'S REPUBLIC OF MOZAMBIQUE

The Ministry of Education has vacancies for:

1. Chief technician to organise the purchasing of industrial equipment for technical schools.
2. Experienced planner/architect to organise the school building programme for technical education.
3. A systems analyst to collect and analyse data relavant to technical education.
4. An experienced educational planner to organise the training of technical teachers.
5. Qualified and experienced technical teachers of electrical trades, building trades, accountancy and secretarial courses, agriculture, general mechanics, motor mechanics, and chemistry.

Further details and application forms from: Mozambique Recruitment Programme, 34 Percy Street, London W1P 9FG (Tel.01-636 7106).

UNIVERSITY COLLEGE LONDON

DEPARTMENT OF PHYSICS AND ASTRONOMY
MULLARD SPACE SCIENCE LABORATORY

Applications are invited for a Post Doctoral Research Assistantship financed by the Science Research Council for work on instrument development and on the analysis and interpretation of data in aithar of the Laboratory's two areas of research – X-ray astronomy and magentospheric physics. The appointment will be for three years, commencing as soon as possible. Salary within the range £4,232 to £6,527 plus US$ membership. Applications, with curriculum vitae and the names of two referees, should be sent to Professor R. L. F. Boyd, C.B.E., F.R.S., at the above address.

Medical Education (International) Ltd

Busy office in central Oxford has openings for two people to join the editorial team. We need another editor to work on leading medical publications, including conference proceedings. Previous experience in publishing and/or scientific background essential. You will be expected to edit manuscripts and progress them through all stages of production, liaising closely with senior members of the medical and nursing professions. Starting salary in the range £3,400-£4,100 according to age and experience.

We also need an editorial assistant to work on all stages of preparing manuscripts for publication. Experience of copy editing, proof reading and handling correspondance a distinct advantage. Common sense and an eye for detail essential. Starting salary in the range £2,800-£3,200 according to age and experience.

Please apply in writing with full cv to:

Dr Judy Hicklin
Medical Education (International) Ltd
52 New Inn Hall Street
Oxford OX1 2BS

TECHNICIAN GRADE 3

required for Department of Anatomy and Embryology. Duties include teaching preparations, upkeep of a breeding mouse colony, tissue culture and assisting with research in blood formation. Previous laboratory experience essential. Knowledge of tissue culture techniques would be an advantage. Salary in range £3,455 to £3,860. Application form from Personnel Officer (Technical Staff FB54), University College London, Gower St., London WC1E 6BT.

UNIVERSITY OF DUBLIN
Trinity College

Lecturers in Statistics (2 posts)
Senior Lecturer in Statistics
(1 post)

Applications are invited for the above posts in the Department of Statistics, Trinity College, Dublin.

Following on the Irish Government's recently announced plans for expanding output of skilled manpower in technology, the Department is initiating a new four-year degree course in Technological Statistics, to commence in October, 1979. The programme will be oriented towards the needs of manufacturing industry and will contain substantial courses in statistics, operations research, systems analysis, computer applications, engineering science and related areas. Successful applicants for the above posts will be expected to participate in this teaching programme.

Salary scale (under review):
Senior Lecturer: £7745-£9527 p.a.
Lecturers: £4317-£8487 p.a.

Appointment to the two posts of Lecturer may be made within the Salary range £4317-£5492 p.a., at a point commensurate with the qualifications and experience of the successful candidates. In the case of all the above appointments, there is a non-contributory pension scheme.

In addition to the above permanent appointments, the Department intends to recruit one or more TEMPORARY LECTURERS, initially for one academic year, in connection both with the expansion proposed above and with other trans-disciplinary activities of the Department of Statistics. Candidates for these temporary appointments may be qualified in a broad range of disciplines, including the agricultural, administrative or engineering sciences.

Persons interested in any of the above positions should, in the first instance, telephone the Staff Office, Trinity College, on Dublin 772941 Ext 1678 or Ext. 1775, or contact the Establishment Officer by Telex 5442 TCD EI.

The closing date for receipt of completed applications will be **26th July, 1979.**

South East Kent Health District

Physiological Measurement Technician (Audiology)

Salary Scale £2,916-£3,639 per annum.

The above vacancy has now arisen in this new District General Hospital of 369 beds. The successful applicant will be based at the William Harvey Hospital, but will also be required to undertake sessions at other hospitals in the District.
Duties include hearing tests, issuing hearing aids, etc.

Application forms available from/returnable to:- The Personnel Department, The William Harvey Hospital, Willesborough, Near Ashford, Kent.

Closing date:- 13th July, 1979.

The William Harvey Hospital Ashford, Kent
Hospital for the future

BCIRA
RESEARCH & DEVELOPMENT
PHYSICIST/ENGINEER FOR DEVELOPMENT OF QUALITY CONTROL TECHNIQUES FOR IRONFOUNDRIES

A vacancy exists in R and D at BCIRA to develop techniques for control of manufacturing processes and quality.

THE JOB:
BCIRA has an extensive programme of research and development on the automatic control of foundry processes and on non-destructive testing. The successful candidate would be primarily concerned with instrumentation and non-destructive testing and would join a group of investigators involved in the development of new techniques including the application of microprocessors and microcomputers. The person appointed will be expected to cover a wide field with many difficult and interesting problems. The work would involve appraisal of problems experienced in iron foundries and possibly some travel and site testing of instruments or techniques developed.

THE PROSPECTS:
BCIRA is the largest organisation in the Western World devoted to the technology of iron castings production, and can offer an unequalled insight into the industry and its processes. Many employed at BCIRA in this way have enjoyed considerable subsequent promotion and developed international reputations. Remuneration will be substantial and not less than current salaries in industry, being dependent on age, experience and qualifications.

THE QUALIFICATIONS:
The successful candidate is likely to have a degree or equivalent in physics, applied physics or in an engineering subject. Some experience of non-destructive testing, especially by ultrasonics, would be an advantage.

The post requires a scientific as well as a practical approach involving the application of physics to the solution of industrial problems.

Preferred age range: 25 - 35.

Removal and professional re-location expenses provided when appropriate.

Requests for application forms, quoting reference No. RES/12, in strict confidence to:

Dr. P.J. Emerson,
Investigations Department,
BCIRA,
Alvechurch,
Birmingham B48 7QB.

Medical Writers

An opportunity to set up a brand new copy team

As an experienced Medical or Ethical Pharmaceutical Writer you'll know our reputation. Merck Sharp & Dohme are an established company manufacturing a wide range of products. Many of our anti-hypertensives, antidepressants, antiarthritics, diuretics and steroids are market leaders and we have an equally successful record in the animal health field.

Now we want to set up our own copy team to conceive and execute new advertising and marketing campaigns and write ethical product literature. We are looking for three creative, original yet highly disciplined writers — one of them senior enough to be Copy Chief — who can make a positive contribution to our Marketing Resources Division.

We recognise that demand for experienced medical writers exceeds supply and our offer is, therefore, a good one. We offer attractive, negotiable salaries backed by a full range of fringe benefits, a stimulating creative environment and generous assistance with your relocation to this attractive part of the Hertfordshire Green Belt.

Please write enclosing brief career details to Clare Bradshaw, Personnel Officer.

MSD
MERCK SHARP DOHME
Merck Sharp & Dohme Limited, Hertford Road, Hoddesdon, Herts. EN11 9BU. Telephone: Hoddesdon 67272

UNIVERSITY OF LIVERPOOL
Bioengineering and Medical Physics Unit
RESEARCH ASSISTANT

Applications are invited for the post of Research Assistant/Senior Research Assistant to work on a research project concerned with the development of an artificial blood vessel.

The project has been running for three years and has led to a prototype vessel which is at present undergoing thorough evaluation, leading eventually to commercial exploitation.

The research assistant will be involved in the application and development of small scale production and testing apparatus, as well as being innovative in making improvements necessary for future generations of prosthesis. He/she will be expected to utilise his/her own specialities and interests in the research and development of the improved product.

The post is most suitable for someone with a degree in a related physical science, an interest in bioengineering and possible research experience. Any queries regarding the post should be made to Mr. R. Clarke, 051-709 6022, ext. 2292.

The initial salary will be on the scale £3,689-£5,321 p.a., or £4,232-£4,776 p.a., for candidates with a Ph.D.

Applications, together with the names of three referees, should be received not later than 20th July, 1979 by the Registrar, The University, P.O. Box 147, Liverpool, L69 3BX. Quote Ref: RV/673.

TECHNICIAN (Grade 5)
required in Department of Microbiology, University of Reading. Main duties include supervision of laboratory services in section dealing with teaching and research in Microbial Physiology and Biochemistry; equipment for teaching and research; chemical stores. Salary according to qualifications and experience in range £3474 £4056 p.a. Further details available on request. Apply, stating qualifications and experience and giving the names of two referees, quoting Ref. TS31A, to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading, RG6 2AH.

Medical Physics Technicians (Electronics)

Your experience could lead to a happy experience in Hampstead

working at the Royal Free Hospital, Britain's newest and largest teaching Hospital.
We offer an experienced Technician (Grade IV — Electronics) the chance of working on the design and construction of specialised electronic equipment, which will be used in both research and clinical applications. This is an excellent opportunity for a man or woman who holds a City and Guilds Final Technological Certificate in appropriate subjects and ideally has experience in the use of both analogue and digital circuit techniques.
In addition to the salary of £4,098-£5,142 p.a. (including all allowances — starting point depending on qualifications and experience), we offer a first class working environment and a superb choice of facilities which include a good staff restaurant, a social club and a brand new recreation and leisure centre with a large sports hall, swimming pool and bar.
If you'd like to find out more, write to Personnel Department, The Royal Free Hospital, Pond Street, NW3, or telephone 01-794 0500, ext. 4286. Please quote reference 0761.
Camden and Islington Area Health Authority (T).

SENIOR EDITOR

The International Schools Division of Macmillan Education Limited need an experienced Senior Editor to take charge of and develop a section of their schools publishing programme overseas, particularly but not exclusively in West Africa.

The job will involve commissioning parts of the list and being responsible for other editors who also commission.

The successful applicant will
- be imaginative and resourceful
- be profit conscious
- have a knowledge of overseas markets
- preferably have a science degree

Please apply with full c.v. to:
M. J. Thorrowgood, Publishing Director, Macmillan Education Limited, Houndmills Industrial Estate, Houndmills, Basingstoke, Hants.

Have you been out of education gaining valuable knowledge in industry or commerce? If so, Strathclyde Department of Education would like to hear from you.

You may have been disillusioned when you first qualified being unable to find a secondary teaching job. It won't happen again. Teaching can offer you job satisfaction, unequalled opportunities for promotion, plus a superb holiday entitlement.

Coupled with new rates of pay, £3768 – £5922, and much more with promotion, (further increases due in January and September 1980) it makes a great package.

Strathclyde urgently needs qualified teachers for most secondary subjects especially Maths, Science Subjects, Technical Education, Art, Business Studies and Music.

People like you can help educate tomorrow's industrialists, today's schoolchildren, with your training and experience.

Did you enter industry with a degree of optimism?

If you would like further information contact:

Gordon Britton, Department of Education, Strathclyde Regional Council, 25 Bothwell Street, Glasgow.

Telephone: 041-204 0022

Strathclyde Department of Education

LEICESTER POLYTECHNIC
School of Chemistry

Applications are invited for four posts to study for CNAA PhD degrees in a small, well motivated and friendly department in which twenty research students are investigating problems in six main areas. These posts are renewable for a maximum of three years.

Post No. 1 Polymer and Adhesion Science. The object is to elucidate the mechanisms by which water affects the durability of epoxide-metal adhesive joints. The programme, which is directed towards aero-space applications, will be supervised by Dr John Comyn and Dr Derek Brewis.

Post No. 2 Electrochemical Oxidations of Organic Compounds. It is hoped to replace such oxidising agents as permanganate and dichromate, which cause severe effluent problems in the pharmaceutical and other industries by electrochemically grown metal oxide films and porous electrodes. The programme is supervised by Dr Roger Latham and Dr Rafi Dahm.

Post No. 3 Solid State Electrochemistry. The aim is to study fundamental aspects, especially of thin interfaces within the cell, of certain silver copper and other novel battery systems. The programme is supervised by Dr Roger Linford.

Post No. 4 Solid State Battery Systems. The project involves the study of solid state battery systems based on novel ionic conductors. The programme is supervised by Dr Roger Linford.

SALARY for posts 1-3 £2,673 p.a. plus annual increments including 6 hours/week of demonstrating/teaching. These are LEA Research Assistantships.

SALARY for post 4. This is a studentship provided by Mallory Batteries (UK) Ltd., present value £2,150 p.a. tax free.

Application forms and further details from the Staffing Officer, Leicester Polytechnic, PO Box 143, Leicester LE1 9BH. Informal enquiries to Roger Linford, Reader in Chemistry (0533-55181, ext. 2202).

RSPCA
requires

Chief Education Officer

The RSPCA wishes to appoint at its Headquarters in Horsham, Sussex, a Chief Education Officer to be responsible to the Communications Controller for the administration of the Education Department at Headquarters and in the field. The Education Department includes 16 qualified Field Officers, and a Headquarters team. It also has its own Education Centre and nature reserve.

The successful applicant will be a qualified teacher who has a good honours degree in biological subjects. Interest in and commitment to animal welfare is an essential pre-requisite. A balanced personality capable of establishing a successful relationship with other members of a wide-ranging management team is important.

Salary is negotiable with other beneficial conditions of service which include eligibility for a contributory management car scheme.

Applications in writing from men and women, preferably not beyond mid 40's, including full curriculum vitae to be addressed as below.

Applications should be addressed to: STAFF RELATIONS AND PERSONNEL MANAGER, The Causeway, Horsham, Sussex RH12 1HG.

UNIVERSITY OF NOTTINGHAM
School of Agriculture
Sutton Bonington, Nr. Loughborough
DEPARTMENT OF PHYSIOLOGY and ENVIRONMENTAL STUDIES

Research opportunities in Environmental Science

1. A fellowship is available for a project supported by the ARC. This is concerned with the physics and economics of very low cost solar energy collectors for use in crop drying and the successful candidate will work with Dr. J. A. Clark and Mr. B. Wilton. The appointment is for 3 years. Candidates should preferably have a PhD or equivalent experience in an appropriate branch of physics, engineering, or environmental science (salary scale commencing £4,776 p.a. at age 26). Applications will also be considered from newly qualified graduates with a good honours degree (salary scale commencing at £3,689 p.a.)

2 The Heat Balance of Wet Vegetation. The duration of leaf wetness is an important factor influencing the development of plant diseases and the uptake of soluble pollutant gases. A PhD studentship is available for a study of micrometeorological processes which determine leaf wetness and to develop computer simulation models. A good honours degree in physics or environmental science is desirable. Candidates will work with Dr. M. H. Unsworth.

Further information may be obtained from the member of staff referred to and applications including a full curriculum vitae with the names and addresses of two referees should be submitted to them at the School as soon as possible.

Electronics Research

Redhill

The Philips Research Laboratories at Redhill are part of the co-ordinated research effort of the Philips Group. The emphasis is on innovation and additional personnel, men and women, are now required to join teams in the following specialist areas at Redhill.

Signal Processing and Display

New projects in the field of high quality and large screen television systems require us to strengthen our team working in this challenging area.

Two Graduate Electronics Engineers are required to work on digital signal processing of video signals and on drive electronics and performance assessment of displays.

In both cases, preferred qualifications are a degree in electronics/electrical engineering, or equivalent professional qualification. Some experience in a relevant field would be an advantage but is not essential. Please quote reference 135.

Robotics

An inventive, practical electronics Design Engineer is required to work as part of a small dynamic team in an exciting advanced project on sensorily controlled assembly robots.

It calls for an enthusiastic 'green fingered' circuit designer with knowledge and experience in large logic systems involving up to the minute technology. The job will involve multi-microprocessor systems, interfacing to minicomputers of sophisticated sensor systems (including TV) and actuators.

Whilst professional help and considerable instrumentation and computer power will be available, the successful applicant will, when necessary, be expected to take a detailed part in the commissioning and documentation of equipment. The appointment offers considerable autonomy and there will be opportunities to contribute considerably to the details of the research programme. Please quote reference 136.

VLSI - High Speed Pattern Generation

The Electron Lithography Group at Redhill is at present conducting a joint research project with another part of the Philips Concern in the Netherlands. As a result, the Laboratories can offer two Electronics Engineers an opportunity to work on the design of a direct slice writing electron beam pattern generator for up to two years before transferring to work on the Philips' permanent staff in Eindhoven.

This is an ideal opportunity for someone, ideally with experience of software or hardware aspects of very high speed digital techniques, to make a significant contribution to a relatively new research project before moving to new challenges in a new country. Please quote reference 137.

Please quote reference when writing or phoning for an application form to M. L. Malpass, Personnel Manager, Philips Research Laboratories, Cross Oak Lane, Salfords, Nr. Redhill, Surrey. Tel. Horley 5544.

PHILIPS Research Laboratories

PHILIPS

UNIVERSITY OF SURREY
Computing Unit
DEPUTY DIRECTOR
(circa £10,175)

During the summer this year the department is installing an integrated system of linked Prime computers — the most advanced and powerful multi-access Prime system in Europe.

A Deputy Director is required for this progressive department and the successful applicant will deputise for the Head of Department for a wide variety of duties both inside and outside the University as appropriate. The Deputy will assist in the running of the Department and will be directly responsible for the management of the User Support Group which provides program advisory, information and teaching services, development of operating system software and libraries, and assists with user projects particularly in computer assisted learning.

Candidates should have a lively and flexible attitude, proven management ability, wide experience in programming, and good academic and professional qualifications.

A negotiable salary on the Computer and Other Related Staff salary scales around £10,175 per annum, plus generous annual leave.

Further particulars may be obtained from the Deputy Secretary (Personnel), University of Surrey, Guildford, Surrey GU2 5XH or telephone Guildford 71281 extension 452. Applications from men and women in the form of a curriculum vitae, including the names and addresses of three referees, should be sent to the same address by: 20th July 1979.

UNIVERSITY OF BRISTOL
Department of Biochemistry

POSTDOCTORAL RESEARCH ASSISTANT

Applications are invited for a postdoctoral research assistant to join a group investigating the hormonal regulation of glutamine metabolism in liver. The appointment is for a maximum of three years and is funded by the Medical Research Council. Salary is within the University Range 1A — £4232 to £7145 per annum (scale subject to revision from 1st October, 1979). Some experience in protein separations techniques would be advantageous. Applications, including a curriculum vitae and the names and addresses of two referees should be sent to Dr. J. D. McGivan, Department of Biochemistry, Medical School, University Walk, Bristol BS8 1TD before July 15th, 1979.

PORTSMOUTH POLYTECHNIC
Biochemistry/Molecular Biology
A LECTURER II/SENIOR LECTURER

is required to undertake teaching and research duties in this field.

The person appointed will take overall responsibility for the teaching of biochemistry and molecular biology within the multi-disciplinary Biomolecular Science BSc courses (3 years full-time, Honours) and will personally teach a major proportion of the material.

Facilities for research are extensive. The existing research group emphasises a multi-disciplinary approach to the structure and function of chromatin and is supported by SRC and CRC.

Salary scale: £4,101 to £6,051 (efficiency bar) to £7,572 per annum (under review).

Further details and application forms from the Staff Officer, Portsmouth Polytechnic, Alexandra House, Museum Road, Portsmouth, PO1 2QQ, to whom completed applications should be returned by 20th July 1979, quoting Ref. No. S57.

BUREAUTECH (SCIENTIFIC STAFF AGENCY)
Top jobs for ONC/HNC/HND/AIMLT BSc. (Chem; Phys; Biol; Med. Lab. subjects; Electronics and Metallurgy.)
Immediate vacancies for Paint, Ink and Surface Coating Technologists. We find you the job free of charge. Tel: 01-959 3517.

MATERIALS/PHYSICAL SCIENTIST

A science graduate (m/f) at post-doctoral or similar level is required to work within the Materials Science Division on the development, assessment and application of electron beam techniques to the characterisation of semiconducting materials, and for investigation of materials problems. Experience with SEM techniques would be an advantage and a working knowledge of semiconductor device behaviour is desirable.

Please apply, giving brief details, to: G. D. Prichard, Administration Manager, Ref. P/044, GEC Hirst Research Centre, East Lane, Wembley, Middx. HA9 7PP.

UNIVERSITY OF PETROLEUM AND MINERALS
Dhahran, Saudi Arabia

Invites applications from qualified candidates to fill the following staff positions open for its Chemical Engineering Department.

Workshop/Maintenance Technician (Senior Technician)

For operation of Chemical Engineering workshop/workshop store, and for maintenance/construction of all Departmental mechanical equipment.

Experience: Wide practical experience of hand tools, machine tools, pipe fitting, welding, maintaining/fitting/construction chemical engineering equipment. C and G, ONC, HNC preferred

Instrumentation Technician (Senior Technician)

Maintenance/construction/fitting of chemical engineering instrumentation, e.g., in heat transfer lab and unit operations/QVF labs. Also, GLC's spectrometers, Recorders, Controllers, New Boiler, etc.

Experience: Fine fitting and instrument electrical/electronic experience required, with maintenance/installation of temperature recorders, controllers, GLC's spectrophotometers and other instruments in a chemical engineering environment.

Minimum regular contract for two years, renewable. Competitive salaries and allowances, free air conditioned and furnished housing if available otherwise housing allowance in case of outside living, and repatriation to and from Dhahran each two year tour. Attractive educational assistance grants for school age dependant children of key staff provided. Local transportation allowance in cash each month. All earned income without Saudi taxes. Ten and a half months duty each year with 45 days paid vacation. Interested candidates should send their applications together with photograph and curriculum vitae including personal data such as home and office addresses and telephone contacts, family status and copies of degrees/testimonials to:

Dr. Abdulaziz Al-Dukhayyil
Dean of Faculty and Personnel Affairs
University of Petroleum and Minerals
P.O. Box 144
Dhahran, Saudi Arabia

SAFETY OFFICER
(TECHNICAL)

The impact of the Health and Safety at Work Act, together with overseas legislation makes increasing demands on the Company to ensure the safe handling of dangerous substances. Consequently, a new post of Safety Officer (Technical) within our Safety and Environment Department will be created.

Reporting to the Senior Safety Officer, the Safety Officer will assist with the assessment, compilation and dissemination of technical safety data for the many substances used on the Company. In addition the Officer will be responsible for advising operational departments on associated legal requirements and safe working systems for certain statutory licences, notification to enforcement agencies and for the co-ordination of Company safety statistics and accident reports.

Applicants, male or female, should be science graduates with two to three years research, development or production experience and who wish to pursue a career away from the bench. An understanding of the chemical, physical and toxicological properties of substances is essential. Training will be given in the specialist requirements of the post.

In addition to an attractive salary, Company benefits include profit sharing and staff purchase privileges. Generous help with relocation to the Nottingham area is available if applicable.

Application forms are available from:
Tom Flower,
Employment Manager (Technical),
Employment Services Department,
The Boots Company Ltd., Station Street,
Nottingham.
Telephone Nottm. 56255 Ext. 243.

Boots

EAST CUMBRIA HEALTH DISTRICT

TECHNICIAN
(Medical Physics Technician IV)

Based in the Intensive Care Unit at the Cumberland Infirmary, Carlisle, the person appointed will maintain and operate specified medical apparatus. Previous experience of work with mechanical/electronic apparatus is essential though it need not necessarily have been in a Hospital. Training, together with the opportunity to obtain further qualifications, will be given.

Carlisle is pleasantly situated near the Lake District, Scottish Borders and Solway Coast. Temporary, single/married accommodation is available.

Salary £3,069-£4,134 p.a. (increasing pending). Further information concerning the post may be obtained from the post holder, Mr. J. A. Ackley. Tel: Carlisle 23444, ext. 681.

Job Description and application form from Hospital Administrator, Cumberland Infirmary, Carlisle. Closing date 12th July, 1979.

TECHNICIAN
£3,474-£3,846 **Ewell**

For the Chemistry Section of the Sciences Department at North East Surrey College of Technology, Reigate Road to set up apparatus and prepare practical experiments for classes.
A knowledge of basic chemistry and qualification to 'A' level, OND or ONC in Chemistry are essential. Some experience would be preferred, 36 hours over 5 days, Monday to Friday. 19 days annual leave plus 10 statutory days holiday.

Application form from the Chief Administrative Officer at the College. Tel: 01-3941731. (Please quote ref. No. CAO/SS/55.

SURREY COUNTY COUNCIL

MEDICAL RESEARCH COUNCIL
Applied Psychology Unit
Cambridge

RESEARCH POSTS

Applications are invited for two research positions at the MRC Applied Psychology Unit, Cambridge. The Unit carries out research which attempts to bridge the gap between experimental psychology and applied problems, and to contribute to both areas. The Unit comprises 30 research staff and a similar number of ancillary staff comprising research assistants, technical staff, secretarial staff etc.
The posts in question may be filled at any of a range of levels, with salary and tenure conditions depending on age and experience. These would range from a limited-term three-year appointment for an immediate postdoctoral, to the senior lecturer laval for a sufficiently qualified applicant. Applications, together with a curriculum vitae and names of two referees should be sent to Dr. A. D. Baddeley, Director, MRC Applied Psychology Unit, 15 Chaucer Road, Cambridge CB2 2EF, England. Candidates are recommended to apply by July 14th, 1979.

Graduate Chemists for Flavour Research

Kennett, Newmarket

We are increasing our flavour activities and need young graduates to meet the challenge offered by interesting new work in this expanding area of basic research. This varied work embraces aspects such as the analysis and synthesis of novel flavour materials as well as the study of the chemistry of flavour development.

The graduates needed to manage these jobs must have recently graduated with or are about to graduate with a good honours degree in Chemistry. Applicants must be self-motivating, be able to respond to a challenge and so add strength to the successful team of flavour researchers.

The jobs are in modern laboratories equipped with advanced instrumentation which are located at our Nutritional and Research Centre at Kennett, Newmarket. On the job training will be given to successful applicants and every encouragement will be given to career development.

Salary is negotiable; there is a contributory pension scheme, four weeks' holiday, flexible working hours.

Applicants should write for an application form to: F. R. Hall, Personnel & Training Manager, Spillers Limited, Research & Technology Centre, Station Road, Cambridge CB1 2JN.

Spillers

AGRICULTURAL RESEARCH COUNCIL
Unit of Invertebrate Chemistry and Physiology
University of Sussex, Brighton

ASSISTANT SCIENTIFIC OFFICER

We require an Assistant Scientific Officer to work on non-routine high pressure liquid chromatographic separations of natural products and analogues. The post would suit a person with experience in chromatography, qualified up to HNC level who wishes to become an expert in this rapidly developing technique. This modern laboratory is well equipped with both analytical and preparative chromatographs servicing several research projects.
Minimum qualifications 4 GCE O levels, Grades A, B or C including English Language and Chemistry.
Salary on scale (under review) according to age, between £1,775-£2,665, rising to £3,304, 4 weeks holiday. Opportunity of day release, non-contributory pension scheme.
APPLY IN WRITING TO THE SECRETARY AT THE ABOVE ADDRESS.

UNIVERSITY OF SURREY
Department of Microbiology
GRADE 6 TECHNICIAN FOR THE VIROLOGY SECTION
£3,984-£4,758 plus comparability study
An experienced and suitably qualified technician, with an interest in virology, is required, to be responsible to the Chief Technician for the running of a suite of laboratories conducting research and teaching in virology.
The person appointed will prepare practical classes for the Reader in Virology and assist in his research, as well as being responsible for the equipment in the section.
The work will involve immunology, tissue culture and electron microscopy. A meticulous worker with good organisational ability is required and a general familiarity with microbiological and biochemical techniques.
For an application form please telephone Guildford 71281, ext 452 or write to the Staff Officer, University of Surrey, Guildford, Surrey GU2 5XH.

UNIVERSITY OF DURHAM
Department of Botany
SENIOR EXPERIMENTAL OFFICER
Applications are invited from candidates with biochemical experience for the post of Senior Experimental Officer tenable from 1 October 1979. Duties include both demonstrating and research plus responsibility for the operation of some physiological and biochemical equipment.
Salary on Range 1A £4,333-£7,521 p.a. plus superannuation.
Applications (3 copies), naming three referees should be sent by 4 July to the Registrar and Secretary, Science Laboratories, South Road, Durham, DH1 3LE, from whom further particulars may be obtained.

PHYSICISTS

AS INFORMATION SPECIALISTS

INSPEC is the leading International Information Service covering Physics and Engineering and is continuing to expand and develop in this fast-growing field. A wide range of printed and computer-generated services is supported by a strong programme of product development and research into new techniques for information storage, retrieval and dissemination.

We are seeking to recruit both new and experienced graduates or equivalent in physics interested in a career in scientific and technical information to join our team of information scientists who carry out the selecting, abstracting, indexing and classification of scientific papers for input to our computer database. Opportunities exist for specialisation in a particular field of interest.

Starting salaries are negotiable and will not be less than £3,700 per annum for graduates seeking their first appointment. Full training will be given and salaries are reviewed after completion of training (normally 6 months). We offer excellent conditions including four weeks' annual leave and flexible working hours in our pleasant new offices at Hitchin, Herts.

If you would like to know more about the possibility of joining INSPEC please write to: Mr P. Clague, The Institution of Electrical Engineers, Station House, Nightingale Road, Hitchin, Hertfordshire SG5 1RJ.

IEE

UNIVERSITY OF NOTTINGHAM
Physics of Air Pollution Dispersion
A GRADUATE IN PHYSICS
environmental science or engineering is required to join a team studying the influence of sulphur dioxide on crop growth. The successful applicant will investigate the turbulent dispersion of SO_2 in the lower atmosphere using a computer-controlled acquisition system which he will establish at a field site. Experience in computer programming and/or field work would be useful. The research project is supported by the Department of the Environment for three years. A suitably qualified applicant may register for a higher degree.
Salary on the scale £3,689-£4,232 p.a.
Application with curriculum vitae and names and addresses of two referees should be sent as soon as possible to Dr M. H. Unsworth, Environmental Physics Unit, University of Nottingham, School of Agriculture, Sutton Bonington, Nr. Loughborough, Leics. LE12 5RD.

BIRKBECK COLLEGE
(University of London)
Crystallography Department
LABORATORY TECHNICIAN (GRADE 5)
Experienced technician for research and teaching laboratories to assist with servicing, modification and construction of electro-mechanical experimental equipment; design and implementation of safety devices associated with specialised X-ray equipment in the Department of Crystallography. Applicants should have HNC or equivalent qualification, be conversant with servicing high voltage generator units and electrical control equipment, and be able to work without supervision. Excellent holidays. Salary on scale £3,998-£4,580 inclusive of London Weighting. Apply with full c.v. to Administrative Assistant (NS), Birkbeck College, Malet Street, London WC1E 7HX or telephone 01-580 6622, ext. 271 for application form.

QUEEN ELIZABETH COLLEGE, KENSINGTON
(University of London)
Department of Chemistry
TECHNICIAN GRADE 4
Applications are invited for the post of Technician Grade 4 from suitably qualified candidates who should hold ONC, OND or equivalent qualifications.
Salary depending upon qualifications and experience, within range £3,746-£4,232 p.a. inclusive of London weighting.
Application forms from Mrs. G. Howard, Queen Elizabeth College, Campden Hill Road, W8 7AH. Tel. 01-937 5411 ext. 499.

SENIOR TECHNICAL OPPORTUNITIES WITH MORGANITE CRUCIBLE

Morganite Crucible Limited are part of a large international group of companies involved in high temperature technology. As part of our continuing development we now have two first-class opportunities for qualified technical personnel.

SECTION HEAD (Minimum £5700 p.a.)

This is a new appointment, created by our expansion, and involves responsibility for the development of special refractories for the iron and steel industry. Other important areas include the implementation of processes developed in our Research Centre, and a problem-solving role within our Factory Technical Department, in terms of product quality.
Candidates should possess a degree in an applied science and a minimum of five years experience in refractories, ceramics or a closely related industry.

SENIOR TECHNOLOGIST (c. £4500 p.a.)

This position demands someone able to work on his/her own initiative and to undertake major projects concerning the development of crucibles for new and specialised applications. Responsible to the appropriate Section Head, he/she will be expected to plan and execute this work to stated objectives and to prepare full technical reports.
Candidates should have a degree in an applied science with at least two years industrial experience.
We can offer a good salary for both positions, and the kind of benefits package associated with a successful company. Relocation expenses to this delightful area of rural Worcestershire will be paid in appropriate cases.
Please write or telephone for an application form to Graham Stenbanks, Staff and Personnel Manager.

Morgan Morganite Crucible Limited, Woodbury Lane, Norton, Worcester. Tel. (0905) 355631.

MICROBIOLOGIST

A vacancy exists in our Evaluation area for a microbiologist. His/her role will be to develop specialised techniques to determine the effect of products on human bacterial flora, particularly in the oral cavity. These techniques will be principally concerned with indentifying changes in the population balance, metabolism and morphology of aerobic and anaerobic organisms in a variety of environments.

The successful applicant will set up a centre of expertise in this field and provide advice on suitable techniques, organise equipment and manpower resources and devise training programmes for junior staff.

In addition to possessing qualifications acceptable for associateship of the I.M.L.S., candidates desirably should have at least five years microbiological experience in oral, veterinary or medical areas and possess a specialised knowledge of techniques in applied microbiology in one or more of these areas.

Our Port Sunlight Laboratory is situated on the Wirral a few miles from the sea and within easy reach of Birkenhead, Chester and North Wales. Interviews will, however, be held at our Isleworth, London Laboratory.

The Company operates a progressive salary policy, contributory Pension Scheme, sickness benefit scheme and other fringe benefits.

Those interested in this vacancy should apply to the address below for an application form.

The Employment Officer
Unilever Research
Port Sunlight Laboratory
Port Sunlight
Wirral
Merseyside L62 4XN

unilever research

TRAINEE SYSTEMS ANALYST

London SW17 £3226 (under review)

Our client, The South West Thames Regional Health Authority, are seeking an ambitious young graduate (science, mathematics or related subjects) for a rewarding career in computer systems analysis.

The Authority offer a wide variety of sophisticated commercial and medical systems work with full formal training in systems analysis and the technical aspects of computing.

For further details of the position, which is based at Tooting, London SW17, telephone Sylvia Lyons on 01-839 3351 or write to:

Modem Computer Services Ltd., FREEPOST, London WC2N 5BR.

Data Processing Staff Consultants
CALL
MODEM
on 01-839 3351

Experimental Assistant

with a scientific approach to farming

At ICI's Plant Protection Division we are engaged in the research and development of pesticides for use throughout the world. Our Research Station at Jealott's Hill, is situated on a 500 acre experimental farm, and it is here that most of our new products are developed and tested.

We are now looking for someone to join us as a Field Trials Experimentalist who will play an important role in our crop protection programme. Working as a member of a research team you would be involved in the setting up of experiments in the field, in looking after their progress and in recording all significant data. This work will be mainly at Jealott's Hill but will also involve trials on farms throughout Southern England.

We see this as a job for a man or woman aged 18-23 who holds an agricultural qualification, or who has achieved 'A' levels in relevant science subjects and has a farming background. As the work will involve visits to other farming establishments, it is important that you feel at ease and enjoy working in this sort of environment. A current driving licence is essential.

Research at Jealott's Hill is helping to shape the future of farming. Here you could gain the sort of field experience needed to build a progressive career in agricultural research and there are opportunities for advancement for the right candidate.

Apart from a good salary, other benefits include a profit sharing scheme and pension fund, good self-service restaurant and recreation club.

Subsidised coaches run to and from Bracknell and Maidenhead. Hours 8.45 am to 5.00 pm Monday to Friday.

If you are interested in applying, please write to or telephone Mr. S. R. Stephenson, Personnel Officer, ICI Plant Protection Division, Jealott's Hill Research Station, Bracknell, Berks. Tel: Bracknell 24701.

ICI Plant Protection Division

UNIVERSITY OF LONDON
KING'S COLLEGE
Department of Biophysics
RESEARCH ASSISTANTSHIP

Applications are invited for the post of research assistant to work on a Cancer Research Campaign — supported project concerned with the interactions of carcinogens and anti-cancer agents with nucleic acids. A degree in biochemistry, chemistry or related fields is required; experience in separation methods and/or handling of nucleic acids would be useful. Starting salary in the range of £3,775-£4,333 + £502 London Allowance. Appointment is for one year in the first instance, starting from October 1979, with the possibility of renewal for a further two years. Applications, with a curriculum vitae and names of two referees, to Dr S. Neidle, Department of Biophysics, King's College, 26-29 Drury Lane, London WC2B 5RL, from whom further particulars may be obtained.

THE CITY UNIVERSITY
Department of Chemistry
POST-DOCTORAL RESEARCH ASSISTANTSHIP

Organic Chemists with interests in biological chemistry are invited to reply for a Post Doctoral Research Assistantship to work in collaboration with Dr J B Hobbs on the synthesis of novel nucleosides with potential antiviral activity. The appointment is tenable for one year from 1st October 1979. The salary will be £4,333 p.a.; (under review) + £502 p.a. London Allowance and U.S.S. Superannuation Benefits.

Applicants should submit a curriculum vitae and the names of 2 referees to Dr J B Hobbs, Department of Chemistry, The City University, Northampton Square, London EC1V 0HB, as soon as possible and not later than 31st July 1979.

LABORATORY TECHNICIAN
required for Flame and Flameless Atomic Absorption work. HNC or similar qualifications, previous experience in this branch helpful, but not essential. Salary in accordance with age and experience on Whitley Council Scale.

Please reply with two references to: The Alfred Chester Beatty Body Dynamics Laboratory, Brooksden, Cranbrook, Kent.

PRODUCTION GRADUATE STERILE PRODUCTS

A vacancy has arisen for a pharmacist (or a suitably experienced chemist or microbiologist) who has had at least 2 years experience in the manufacture of sterile products.

The successful candidate will be responsible to the Production Manager for a team engaged in the manufacture and filling of sterile opthalmic products, including eye drops and contact lens solutions.

The work will be located in a modern clean room complex with adjacent aseptic areas offering the successful candidate further experience in pharmaceutical technology, management and G.M.P.

The post will be located at our pharmaceutical plant in New Malden.

The salary and general benefit package would be that appropriate to a forward-looking company and includes relocation allowance, where appropriate.

Please write in confidence for an application form or 'phone if you wish to discuss this appointment further before applying:

Dr. J. B. Kay, Technical Director,
CONTACTASOL LIMITED,
Ruxley Towers,
Claygate, ESHER, Surrey.
Tel: 01-949 5616

AGRICULTURAL RESEARCH COUNCIL

Food Research Institute

Scientific Services & Development Division

CHEMIST

A Scientific Officer is required to join, on a temporary basis, the Chromatography Development Group which is part of the Scientific Services and Development Division. The appointment relates to a research contract ending in October 1980, which has as its objective the estimation in poultry waste of residues of specified veterinary products. Published gas chromatographic methods will be worked up but some method development will be necessary.

A pass degree or HNC in chemistry, together with a knowledge and practical experience of high performance liquid chromatography and/or gas chromatography, are required.

Salary: on a scale £2,839-£4,415 (under review).

Five day working week and flexible working hours scheme operated. Transport facility available mornings and evenings.

Further particulars and application forms from The Secretary, Food Research Institute, Colney Lane, Norwich NR4 7UA quoting Ref. No. 79/9. Closing date: 11th July 1979.

FORMICA

Resins Chemist

Formica Limited has a vacancy for a Resins Chemist at its Research Centre situated in pleasant surroundings on the outskirts of Maidenhead.

If you are interested in joining a team carrying out research and development in the thermosetting resin field with the objective of keeping the Company in its leading position in the decorative laminate business, we would like to hear from you.

You should have an Honours Degree in Chemistry plus about 4 years post-graduate experience in the chemistry and application of resins, possess a sound practical capability and the ability to supervise the work of subordinates.

A competitive salary is offered, according to qualifications and experience.

Employment benefits include free membership of BUPA, four weeks annual holiday, a contracted-out pension scheme and a subsidised canteen.

Please write or telephone for an application form to Mr. P. W. Yeomans, Formica Products Research Centre, 68, Lower Cookham Road, Maidenhead SL6 8LA. Telephone Maidenhead (0628) 21441.

CYANAMID

ANALYST — PROGRAMMER

For Drug Research

We have a vacancy in the Section which has the function of providing a computing service to our Pharmaceutical Research and Development Laboratories. The Computing Section is at the start of a period of development and new implementations are planned in the following broad areas:
on-line data capture from safety evaulation experiments
interactive information (text) retrieval
managements of structured experimental data, including its interfacing to application programs
network analysis and project management
The computing facilities available will include an ICL 2960 and DEC PDP-11 equipment.
Applications are invited from programmers and systems analysts, ideally science graduates, who have some experience working with one or other of these machines, or have knowledge of some of the applications described. For the maintenance of existing systems it would be desirable that the person concerned has experience of COBOL, and usefully also of FILETAB and COIN. Initially, the person appointed would be involved in evaluating alternative means for implementing the applications outlined above, and subsequently they would carry through implementations up to and including hand over to user and maintenance.
The benefits of working for Fisons include flexible working hours, an active Sports and Social Club and pension facilities. An attractive salary, depending on experience, is offered and assistance with re-location where appropriate.
Applicants (male or female) please write to Mr Bryan Johnston, Fisons Limited — Pharmaceutical Division, Bakewell Road, Loughborough, Leicestershire LE11 0QY. Tel: 0509 66361. Please quote reference number 968R/NS.

FISONS

PHARMACEUTICAL DIVISION

SENIOR CHEMIST

DENTAL PRODUCTS

A vacancy has arisen for a senior chemist in our new Laboratories, situated at Weybridge, to carry out research and development on products for dental restorative applications.
Applications are invited from chemists with a minimum qualification of B.Sc and at least four years industrial experience, although preference will be given to chemists having relevant dental product experience, a back-ground in polymer science would be advantageous.
A competitive salary will be offered and it is anticipated that the successful applicant will be capable of progressing to the position of Product Development Manager and assuming responsibility for a team working on dental products in a reasonably short period of time.
Other benefits include free dental treatment, a subsidised canteen and a contributory pension scheme.
Applications in writing together with curriculum vitae to:

Joan Novell (Mrs) — Personnel
AD International Limited
Hamm Moor Lane, Addlestone
Weybridge 43902 and 53141

Scientific Officer

£5,857-£6,217

We require a Senior Analyst in the laboratory of our
Beddington Sewage Treatment Works, Beddington Lane, Croydon, Surrey
to assist with all aspects of chemical analysis of sewage and trade effluents.
Several years experience in this type of work is essential, together with the ability to work with a small group as the Senior Assistant Analyst. It will also be necessary to assist in the day-to-day running of the laboratory and investigational work on the site; and deputise for the Assistant Manager (Scientific) in his absence.
The qualifications expected for this post are a degree in Chemistry or equivalent.
Application forms are available from Miss Lesley Ambrose, Personnel Branch, 50-64 The Broadway, London, SW1H 0DB. (Telephone 01-222 6200). Please quote reference 137.
All salaries are currently under review.

Thames Water

Wellcome

Laboratory Technicians

£58-£74 per week

Technicians with laboratory experience and at least 'O' level qualifications (and preferably, as appropriate ONC) are required for the Wellcome Research Laboratories in the following areas:

1) Analytical Chemistry

This laboratory, part of The Quality Control Division, provides a general analytical service to the site, and uses a wide range of automatic and instrumental techniques (including I.R., U.V., and atomic absorption spectroscopy), together with traditional "wet chemical" methods.

2) Control Sera Production

The clinical chemistry laboratory handles, analyses and processes bulk bovine serum to produce standard reference sera for quality control purposes in (e.g.) automatic analytical equipment.

3) Virus Vaccine Production

Production of both egg-based and tissue-cultured human and veterinary vaccines is carried out in our laboratories. Processes include incubation, inoculation, homogenisation, and filtration techniques.

We are keen to recruit technicians with experience of these techniques, but are prepared to train those with other biological skills.

Our Research Laboratories are situated in pleasant parkland surroundings. Excellent benefits include 4 weeks' holiday, pension, life assurance and sick pay schemes, subsidised canteen and sports and social facilities.

Please write for an application form to: R. V. Sutton, Personnel Officer, The Wellcome Research Laboratories, Langley Court, Beckenham, Kent BR3 3BS, quoting reference number AQ/49.

THE UNIVERSITY OF PAPUA NEW GUINEA
(Port Moresby)
Department of History of Science and Technology

Applications are invited for the following post:

SENIOR LECTURER/LECTURER

The appointee must have a higher degree in the History of Science and Technology or related discipline with interest and experience in this field. Preference will be given to those with demonstrated background, as well as intermediate technology or technology transfer to the Third World. Experience in teaching students for whom English is not a first language will be an asset.

Salary scale: Senior Lecturer K15,150 pa, Lecturer K13,300 pa, (£1 sterling = K1.48.) Family passages; 3 year appointment: gratuity 24% of salary of which 5% is taxable; baggage allowance; various other allowances. Detailed applications (2 copies) with curriculum vitae and naming 3 referees to be sent direct to the Secretary, University of Papua New Guinea, Box 4820, University PO, Papua new Guinea by 3 August 1979. Applicants resident in the UK should also send one copy to Inter University Council, 90/91 Tottenham Court Road, London, W1P 0DT. Further details may be obtained from either address.

JOHN INNES INSTITUTE
Department of Genetics

SCIENTIFIC OFFICERS

(two) required (i) to assist with research programme on the genetics of the Rhizobium/legume symbiosis (ii) to develop symbiotically improved strains of Rhizobium.

Applicants should hold a degree in microbiology, biochemistry, botany or a related field. Salary £2839 - £4415 (pay increase pending). Starting salary depending on qualifications and experience. Non-contributory superannuation.

Further particulars may be obtained from the Head of the Genetics Department, Professor D. A. Hopwood. Applications, quoting reference Gen/38/40, giving details of qualifications and experience and the names of two referees, should be sent to the Secretary, John Innes Institute, Colney Lane, Norwich, NR4 7UH, not later than 12 July, 1979.

UNIVERSITY OF YORK

Department of Biology

POSTDOCTORAL ECOLOGIST

Applications are invited for the above post available from 1 October 1979 or as soon as possible thereafter to work on the factors affecting distribution and abundance of Antarctic soil arthropods. The research relates to both the community and decomposition ecology of the Maritime Antarctic. The Research Assistantship is supported by a 3½year grant from NERC, and there is provision for Antarctic field work, in collaboration with the British Antarctic Survey, from late 1980 till the spring of 1982. Candidates must be medically fit. Starting salary £4,333 pa (under review), plus superannuation.

Three copies of applications and curricula vitae, naming three referees (two academic and one character), should be sent by Thursday 12 July to the Registrar, University of York, Heslington, York, YO1 5DD. Informal enquiries to Dr. M. Usher, Department of Biology, tel. York, YO1 5DD. Informal enquiries to Dr. forms. Please quote reference number 12/6108.

Royal Dental Hospital of London
School of Dental Surgery
Department of Anatomy
at St George's Hospital Medical School
Tooting SW17

LABORATORY TECHNICIAN (RESEARCH) GRADE 3

A Laboratory Technician is required for a research laboratory. Duties will be concerned with Histology, Photography, Organ Culture and Electron Microscopy (scanning and transmission).

Elementary training can be given in any or all of these techniques. The position is suitable for someone wishing to broaden his or her experience without commitment to a single speciality.

Salary will depend on suitability and/or experience but will probably be on the scale for Grade 3 Laboratory Technician, University of London (ie £2,931-£3,336 per annum plus London Allowance).

Further details may be obtained from Dr A F Hayward, Department of Anatomy, Royal Dental Hospital of London School of Dental Surgery, St George's Hospital Medical School, Tooting SW17 0RE (01-672 1255 Ext 4633/4610), to whom applications together with names and addresses of two referees, should be submitted by 14 July 1979.

EAST BIRMINGHAM HOSPITAL
REGIONAL CYTOGENETICS LABORATORY

Applications are invited for the post of Scientific Officer. Experience in medical cytogenetics including cell tissue culture desirable but not essential. Salary range depending upon experience and qualifications £2,991-£4,899 per annum.

Application forms and job description obtainable from Regional Cytogenetics Laboratory, East Birmingham Hospital, Bordesley Green East, Birmingham B9 5ST. Tel. 021-772 4311, ext. 4354.

UNIVERSITY OF BRADFORD

2 year FIXED TERM LECTURESHIP in Physics

Applications are invited from suitably qualified physicists for the above post commencing October 1979. The research interests of the School of Physics lie in Physical Electronics and Nuclear Structure Physics, applicants should be qualified to pursue research in one of these fields. Consideration given to applicants completing a PhD this summer. Salary within the range £4232 to £8452 per annum (under review)

Further details and application forms (to be returned by 13 July 1979) obtainable from the Registrar, Post Ref. PY/L/28/L, University of Bradford, BD7 1DP.

Are you interested in a career in

Publishing/Journalism in the Biomedical Sciences

Opportunities exist with Elsevier/North-Holland Biomedical Press in Amsterdam and in Cambridge for people with research experience in the Biomedical sciences, especially immunology, parasitology, physiology, pathology or toxicology. Applicants should also have writing and organisational abilities and an interest in research trends outside their own immediate discipline.

We have opportunities in Amsterdam for individuals to develop our biomedical publishing programmes and in Cambridge to work on our range of current awareness magazines for research scientists.

Write with career details to: *Dr. A. Grimwade, Elsevier/North-Holland Biomedical Press, 14A Regent Street, Cambridge CB2 1DB, UK. Phone (0223) 59787.*

RESEARCH AND DEVELOPMENT CHEMISTS

DENTAL PRODUCTS

Owing to relocation to new laboratories at Weybridge, vacancies exist for chemists to carry out research and devleopment on dental products.

Minimum qualification required is a B.Sc or equivalent and experience in polymer/resin research would be an advantage.

A wide range of competitive salaries will be offered according to age and experience.

Other benefits include free dental treatment, a subsidised canteen and a contributory pension scheme.

Applications in writing together with curriculum vitae to:

Joan Novell — Personnel
AD International Limited
Hamm Moor Lane, Addlestone
Weybridge 43902 and 53141

UNIVERSITY OF MANCHESTER
RESEARCH ASSISTANTS IN COMPUTATIONAL CHEMISTRY

Applications are invited for two appointments in the Department of Chemistry associated with on-line retrieval of chemical data, in particular related to 13C NMR. The work will include the design and implementation of a retrieval system to be integrated with other chemical data banks supported by the Science Research council (eg. the Crystal Structure Search and Retrieval system). The appointments will be for three years, starting as soon as possible. Initial salary within the range £3,775-£5,488 p.a. Superannuation. Particulars and application forms (returnable by July 10th) from the Registrar, The University, Manchester M13 9PL. Quote ref. 149/79/NSC.

UNIVERSITY OF SOUTHAMPTON
RESEARCH ASSISTANT IN HELICOPTER DESIGN

Applications are invited for the post of Research Assistant to undertake a period of research into the mathematical techniques for designing helicopters.

Applicants should be engineering graduates who have a wide knowledge of helicopter aerodynamics, structures and weight analysis and also be proficient in programming using FORTRAN IV or similar languages.

Salary will be in the range £3,689-£4,232.

Applications, giving a brief curriculum vitae and the names of 2 referees should be sent to D. A. S. Copland, The University, Southampton SO9 5NH, by 6 July, quoting reference 207/R, N.Sc.

THE UNIVERSITY OF MANCHESTER
TEMPORARY LECTURER IN PHYSIOLOGY

Applications invited for this one-year post (tenable from September 1st) from candidates with a higher degree in physiology or related subjects, or medical qualifications registrable in U.K. The appointee will teach medical, dental and science students. Excellent research facilities. Salary range p.a.: £4,232-£5,048 (£4,333-£5,199 from October 1st). Particulars and application forms (returnable by July 9th) from the Registrar, The University, Manchester, M13 9PL. Quote ref: 145/79/NS.

Licensed Technician

Toxicology

Smith Kline & French Laboratories Limited is the UK subsidiary of a leading international pharmaceutical company.

The Research Institute now has an opportunity for a Licensed Technician to join the Toxicology Department to carry out work on the safety evaluation of new compounds.

We are looking for a young man or woman with one or two years experience in this field. Possession of a Home Office Licence is highly desirable and preference will be given to candidates who possess a Driving Licence.

Occasional week-end working will be required for which over-time will be paid.

In addition to good salaries and an annual bonus we offer a wide range of benefits, which include a subsidised cafeteria, flexitime and a growing sports and social club.

Please write or telephone for an application form quoting reference number NSC 146 to Kate Viscardi, Recruitment Administration Officer,

Mundells, Welwyn Garden City,
Hertfordshire AL7 1EY.
Telephone Welwyn Garden 25111
extension 26.

SK&F
a SmithKline company

UNIVERSITY OF SURREY
Computing Unit
APPLICATIONS PROGRAMMER

During the summer this year the Department is installing an integrated system of linked Prime computers — the most advanced and powerful multi-access Prime system in Europe.

Applications are invited for the post of Applications Programmer within the Computing Unit and the successful candidate will be expected to work on the development of software for the new system.

The salary will be on the Computer and Other Related Staff Scale up to £7,145 (£7,521 from 1 October 1979) plus generous annual leave.

Further particulars can be obtained from the Deputy Secretary (Personnel), University of Surrey, Guildford, Surrey GU2 5XH, telephone Guildford 71281, extension 452. Applications from men and women in the form of a curriculum vitae, including the names and addresses of two referees, should be sent to the same address by 13 July, 1979.

RESEARCH TECHNICIAN GRADE 3

required in Department of Genetics, University College, London, to study the development of gonads in male-sterile mice. The project is funded by the MRC. Candidates should have a suitable qualification in biology and good technical ability. Salary in range £3,455-£3,860 inclusive of London Weighting. Five weeks' annual paid holiday plus statutory and customary days giving one week at Christmas and Easter. Full details and application form from Personnel Officer (Technical Staff CH1), University College, London, Gower St. WC1E 6BT.

TECHNICIAN Grade 2B

required to assist in the teaching laboratories of the busy Department of Physiology. Duties include the preparation of equipment and material for specialised courses, as well as general classwork. Qualifications — ONC or City and Guilds 735, Part 2. Salary in range £3,281-£3662 inc. of London Weighting. Five weeks' paid annual holiday plus statutory and customary days giving one week at Christmas and Easter. Application form from Personnel Officer (Technical Staff FF13) University College London, Gower St., London WC1E 6BT.

Research Officer

FRACTURE MECHANICS

£5985-£9890 **KENT**

Applications are invited for a Research Officer to join a multi-disciplinary section within the Component and Plant Integrity Division of the Scientific Services Department based at Gravesend, Kent. The appointed officer will be required to undertake work on integrity assessment of rotating machines and structures within power stations. In particular the person will be expected to apply fracture mechanics techniques to defect assessment and undertake research work directed towards improving the theoretical basis of these assessment procedures. A good honours degree in applied mathematics, physics or mechanical engineering is required. Post graduate research or appropriate experience in either fracture mechanics or mathematical modelling of materials problems would be desirable. A creative scientific ability is of major importance.

Salary within a scale of £5985 to £9890 per annum according to experience (currently under review).

Applications giving full details and quoting Vacancy Number **1378/79/NS** should be sent to the Personnel Officer (Recruitment), Central Electricity Generating Board, Bankside House, Sumner Street, London SE1 to arrive by **20 June 1979.**

Central Electricity Generating Board
SE Region

NATIONAL VEGETABLE RESEARCH STATION
ASSISTANT NEMATOLOGIST

A SCIENTIFIC OFFICER is required with work on the nematode pests of vegetables.

The appointment will be in the grade of Scientific Officer salary scale £2,839 per annum rising by annual increments to £4,415. (Salary review 1 April 1979 pending).

Minimum qualifications required is a degree or equivalent in Biological Science and experience in Nematology would be an advantage.

Non-contributory employers' additional pension scheme.

Full particulars and application form (to be returned by 18 July 1979) from the Secretary, National Vegetable Research Station, Wellesbourne, Warwick CV35 9EF.

THE UNIVERSITY OF MANCHESTER
Department of Pathology
TECHNICIAN (GRADE 2B)

Applicants should have an O.N.C. in Medical Laboratory Subjects and 3 years or more experience in a medical laboratory. The Department is a specialised histopathology one and offers excellent training facilities to obtain the H.N.C. in Histopathology.

Salary scale £2,757-£3,138 p.a. This is currently the subject of a pay comparability study.

Applications with full details of age, qualifications and previous experience and the names of two persons to whom reference may be made should be sent to the Senior Chief Technician, Department of Pathology, Stopford Building, The University, Manchester M13 9PT.

Graduate Chemist

An opportunity exists to join a research team investigating novel compounds for evaluation as anti diarrhoeal agents. The person appointed to this position will synthesise novel compounds for biological evaluation. This opportunity to gain varied experience in the design and synthesis of pharmacologically active compounds should appeal to newly qualified PhD's or to chemists with a good honours degree.

Walton Oaks is pleasantly situated near Dorking and Reigate. Conditions of employment are excellent and include flexible working hours.

If you wish to be considered for this appointment please submit a full curriculum vitae (including details of current salary where relevant) to the following address by July 20th, 1979 or telephone for an application form to be returned by the same date **Mrs. M. R. Minchin, Personnel Officer, Beecham Pharmaceuticals Research Division, Animal Health Research Centre, Walton Oaks, Dorking Road, Tadworth, Surrey. Telephone Tadworth 4444.**

Beecham
Pharmaceuticals

THE POLYTECHNIC OF CENTRAL LONDON

SCIENCE DIVISION

GRADE 3 TECHNICIAN
(PHYSIOLOGY)
Salary: £3,456-£3,861 inclusive of London Allowance

GRADE 4 TECHNICIAN
(MICROBIOLOGY)
Salary: £3,747-£4,233 inclusive of London Allowance

Physiology Technician required to assist the Technician in charge of the physiology laboratories of the Science Division.

Microbiology Technician required to work in the Media Kitchen producing large quantities of media for use in both teaching and research laboratories of the Science Division.

Applicants should have ONC, OND, C & G Part I or two GCE 'A' Levels with three years experience for the Grade 3 post and seven years experience for the Grade 4 post (including training period).

Application form from the Establishment Officer, PCL, 309 Regent Street, London W1R 8AL (Tel. 01-580 2020 ext. 212).

LEICESTER UNIVERSITY
Primary Communications Research Centre
DIRECTOR

Applications are invited for the above post to be supported by a grant from British Library (R & D) Dept. The person appointed will preferably have some experience both of research and of an appropriate area of primary communications (e.g. scholarly publishing).

Salary will be on Range III of the scale for Research and Analogous staff. Salary scales at present: £8,182 to £10,097 with Agreed Scales at £8,698 to £10,775 and subject to further review expected to be effective from 1 October 1979).

The appointment will date from 1 October 1979 or as soon as possible thereafter.

Further particulars and forms are available from Professor A. J. Meadows, Primary Communications Research Centre, University of Leicester, Leicester LE1 7RH, to whom applications must be returned by 13 July.

UNIVERSITY OF LONDON
The Middlesex Hospital Medical School
Department of Biology as Applied to Medicine
A SCIENTIFIC OFFICER

to work on the development of the mouse mammary gland with reference to invasiveness. The appointment would be for two years starting October 1, 1979. Experience in cell biology would be an advantage. Salary according to age and experience, up to £5,304 including London Allowance. Applications, together with the names of two referees to Professor L. Wolpert, Department of Biology as Applied to Medicine, The Middlesex Hospital Medical School, London W1P 6DB.

MEDICAL REPS

Experienced and Trainees. Many vacancies throughout the U.K.

Excellent Sals. and prospects.

Telephone 01-823 3912

Ann Finlay, Bishopsgate Emp. Agy., Ridgway House, 41 King William St., EC4R.

National ADHESIVES and RESINS LIMITED

CREATIVE CHEMIST FOR A NEW MARKET

Holt Melt Pressure Sensitives represent a growing market and we are seeking a Chemist (degree level or equivalent) who will steer our progress. Involvement will be in bench work and production scale up for new formulation development, field technical service, laboratory demonstrations on pilot coater and generally monitoring our market progress by working closely with a Sales and Marketing team. Some overseas work could be involved, together with training in the USA.

The emphasis will be on a practical flair and commercial judgement rather than pure research and a specific background in adhesives is not particularly sought. Whilst bench chemistry is involved, a temperament capable of initiating and supervising a demanding technical/marketing programme is sought.

National Adhesives and Resins Ltd. is part of a large international group with a major share of the industrial adhesives market. Conditions of service will reflect the outlook of a modern progressive company. Please ring SUE BARBER on Slough 33494 for an application form.

Chemical & Mechanical Project Engineers (Hon Graduate)

The Laboratory is seeking to recruit Chemical and Mechanical Engineers to work on projects from inception to pilot plant design/operation. Processing work is organised into basic core area groups covering processing of complex materials (e.g. Powder, viscoelastic Liquids and Solids) together with disciplinary aspects (e.g. reaction engineering, separation processes, biochemical engineering).

Staff are expected to move between groups and projects in order to gain experience. These vacancies will therefore be of particular interest to new graduates and those with up to 3 years post graduation experience. They will also be of interest to those who see Research as a career as well as those who seek the sort or experience that only research can provide before seeking to advance their career elsewhere in this concern. The attainment of Chartered Status is encouraged.

Successful candidates will be offered positions as Assistant Scientists, on a progressive salary, and the opportunity to develop their potential and obtain promotion to Scientist/Management grade.

The Laboratory is situated on Wirral Peninsula a few miles from the sea and convienient for Birkenhead, Liverpool, Chester and North Wales. Where appropriate, financial assistance will be given for relocation.

Interested persons should apply for an application form to:

Employment Officer, Unilever Research, Port Sunlight Laboratory, Port Sunlight, Wirral, MERSEYSIDE L62 4XN.

unilever research

The University of New England

LECTURER

Agronomy

Applications are invited for a tenured lectureship from persons with a professional and research background and interests in the field of crop and/or pasture agronomy. Applicants will be expected to have a PhD and/or considerable professional experience. The latter would be an asset in this position as the successful applicant will be expected to integrate the various components of crop and pasture production in a managemant oriented approach to teaching and research.

The Department is involved in teaching in the faculties of Rural Science and Economic Studies and has research interests in the general area of systems agronomy, including crop adaptation, plant/water relationships, weed ecology, plant nutrition and soil fertility and management.

Further information can be obtained from Professor J. R. McWilliam, Head of the Department of Agronomy and Soil Science.

The appointment will be available from 1st February, 1980.

SALARY RANGE: $A15,786-$A20,737 per annum.

CLOSING DATE: 1st August, 1979.

Other conditions include superannuation, assistance with travel and removal expenses, with buying a house and with initial accommodation in Armidale.

Applications, including the names and addresses of three referees, should be sent to the Staff Officer, University of New England, Armidale, New South Wales, 2351, Australia prior to the closing date.

ARMIDALE, N.S.W. AUSTRALIA

Salford Area Health Authority (Teaching)

Department of Orthopaedic Surgery, Clinical Sciences Building, HOPE HOSPITAL

ECCLES OLD ROAD, SALFORD M6 8HD

Research Technician

A Research Technician is required to assist in projects related to Knee conditions. The person appointed should have experience in Histopathological techniques, especially the processing of undecalcified bone. Previous experience with tissue culture preferred but not essential. The post is for 2½ years, reviewable after 1 year. H.N.C. or equivalent qualification required.

Salary will depend upon qualifications and experience but will be within the scale £3,261 rising to £4,680.

Application forms and further information can be obtained from the Sector Personnel Officer, Hope Hospital, 061-789 7373 Ext. 202 to whom they should be returned.

BRIDGE CHEMICALS
Information Scientist

Bridge Chemicals Limited is the UK Manufacturing and Chemical Development facility of the Chemicals Division of the SmithKline Corporation, a leading international pharmaceutical company, and is based at Tonbridge, Kent.

Due to expansion in our Chemical Development Department, we require an Information Scientist. The successful candidate will be required to provide a complete information service in the field of organic chemistry including safety and hazard data.

Suitable candidates should have an honours degree in chemistry and experience of or qualifications in information retrieval. They must be able to work independently and have a keen interest in chemical information retrieval.

We offer a competitive salary which will reflect the ability of the person we are seeking. In addition, we offer a discretionary annual bonus, free life assurance, an excellent contributory pension scheme and flexible working hours. Assistance will be given with removal expenses where appropriate.

Please send full curriculum vitae, quoting reference BD 9/5 to:
Mrs. P.D. Whitton, Personnel Administrator,
Bridge Chemicals Limited, Old Powder Mills, Nr. Leigh,
Hildenborough, Kent TN11 9AN.

a SmithKline company

THE POLYTECHNIC OF CENTRAL LONDON
Science Division

ELECTRONICS TECHNICIANS

Required in the workshop and electronics/digital teaching laboratories of the Science Division.

Duties in these areas include the design, development and maintenance of a wide range of scientific instrumentation as well as the development of new experiments in analog and digital electronics and microprocessors for use by undergraduate, postgraduate and short course students.

Grade 7 Technician Salary: £5,163-£5,736 inclusive of London Allowance to be responsible for the above areas.

Grade 6 Technician Salary: £4,509-£5,283 inclusive of London Allowance to work in electronics, digital and microprocessor teaching laboratories.

Grade 3 Technician Salary: £3,456-£3,861 inclusive of London Allowance to work in the electronics workshop.

Qualifications: Grades 6 and 7 — HNC/HND or Final C&G plus several years of experience; Grade 3 — ONC/OND or Intermediate C&G plus experience. In the lower graded posts consideration would be given in respect of industrial experience in lieu of academic qualifications.

Application form and further details from the Establishment Officer, PCL, 309 Regent Street, London W1R 8AL. (Tel. 01-580 2020 ext. 212).

UNIVERSITY OF SURREY
Multi-Disciplinary Development Project

Applications are invited for the post of

RESEARCH FELLOW

on an industrially financed project involving the development of a novel sensitised coated paper. The appointment would be for 12 months with the expectation of an extension of up to 12 months. In the event of success with the experimental work, the appointee would be offered employment by the sponsor to carry the project through to commercial exploitation.

The initial salary for this pensionable post will be in the range £4,232-£4,776 p.a. depending upon age and experience. The post would ideally suit someone with approximately two years industrial experience and a background in either polymer science or chemistry.

Applicants should write, giving details of age, qualifications and relevant experience, to: Dr. R. D. Podd, Department of Chemistry, University of Surrey, Guildford, Surrey GU2 5XH.

LONDON BOROUGH OF HARINGEY
Education Service
Tottenham School, Selby Road, N17

Full-Time Laboratory Technician

Salary/Grade — NJC Technical Grade 2 — £3,600 per annum rising to £3,972 per annum inclusive.

This is a large comprehensive school with a purpose built suite of 9 laboratories.

The successful candidate will be required to work as a member of a team of technicians and teachers in the science department. Duties will involve working in all areas of science while specialising in Physics or Chemistry.

Special Qualifications:- Ordinary National Certificate or Ordinary National Diploma, City and Guilds Laboratory Technicians Certificate, 4 GCE passes with 2 at A Level in appropriate subjects, Membership of Institute of Science Technology or an equivalent suitable qualification or 5 years suitable experience.

Details obtainable from:- Chief Education Officer, Education Offices, Somerset Road, N17. Forms returnable by:- 13th July, 1979.

THE CITY UNIVERSITY
Centre For Information Science
TEMPORARY LECTURESHIP

Applications are invited for a temporary lecturership for one year from October 1st 1979 or as soon as possible thereafter. Any well qualified applicants will be considered but help is particularly sought in the areas of foreign information, systems, classification and community information.

Salary will be on the scale: £4,333 to £8,992 per annum plus £502 London Allowance.

Further particulars and application forms may be obtained from the Deputy Academic Registrar, The City University, Northampton Square, London EC1V 0HB. (Tel: 01-253 3499 ext. 338). Please quote reference IS/248/NS. Closing date 30th July 1979.

UNIVERSITY OF DUBLIN
Trinity College

NEW DEVELOPMENTS IN ENGINEERING

Following the decision of the Irish Government to make funds available to increase the number of student places in engineering sciences in universities and other third level institutions, Trinity College, Dublin, wishes to give notice of its intention to recruit a significant number of academic and technical staff in:

ELECTRICAL/ELECTRONIC ENGINEERING
MECHANICAL/PRODUCTION ENGINEERING
COMPUTER SCIENCE
STATISTICS PHYSICS
CHEMISTRY MATHEMATICS

Persons interested in being considered for a post in any of the above areas are invited to telephone the Establishment Officer at the Staff Office, Trinity College, on Dublin 772941, Ext. 1678 or 1775, in the first instance.

Further, more detailed announcements will appear shortly.

IMPERIAL CANCER RESEARCH FUND

TECHNICIAN/ RESEARCH OFFICER

(1) required to assist in our Membrane Physiology Laboratory on projects involving the regulation of cellular metabolism and growth. Experience of cell culture techniques, column chromatography and gel electrophoresis desirable. Two years experience in a biochemistry laboratory essential. Reference MP1.

(2) to work in the Tumour Virus Genetics Laboratory on projects involving the analysis of nucleic acids of mammalian cells and viruses and the molecular cloning of eucaryotic genes. Experience in the preparation and standardisation of restriction enzymes, cell culture techniques, nucleic acid purification and gel electrophoresis would be desirable. Reference TVG1.

HNC or Degree in biological science, but school leavers with two science 'A' levels may be considered. Salary range £3,600 to £5,250. For further information and application form write or telephone, quoting the above reference, to Miss S. M. Hurley, Imperial Cancer Research Fund, Lincoln's Inn Fields, London WC2 on 242 0200 ext. 305.

WASTE DISPOSAL DEPARTMENT

ASSISTANT HYDROGEOLOGIST

£5,232 - £6,060 **Post ref. WD.575**

To provide professional support to the Principal Hydrogeologist and a hydrogeological service for the Waste Disposal Department. Applicants should be qualified hydrogeologists with post qualification experience. Membership of the Institute of Geologists and experience in engineering geology advantageous.

Relocation expenses available. Pay award pending. Salary negotiable within range at interview.

Detailed applications (no forms) setting out qualification and experience, post reference number, present and previous appointments to County Personnel Officer, West Midlands County Council, County Hall, Birmingham B4 7DJ by 9 July 1979.

University of Stirling
Technological Economics Research Unit

Applications are invited from graduates in chemical engineering or metallurgy for a studentship (£2,320 p.a.) for research on

COST ESTIMATION AND ECONOMIC EVALUATION OF NOVEL NON-FERROUS SMELTING PROCESSES

The work is supported by the Department of Industry's Warren Spring Laboratory.
The programme includes training in Technological Economics, where appropriate:

Details from:
Professor D. H. Allen
Dept. of Management Science & Technology Studies
University of Stirling
STIRLING, FK9 4LA. GB.

UNIVERSITY OF ABERDEEN
TECHNICIAN
required to look after the electron-microscope unit in the Department of Botany and to undertake a range of work associated with transmission and scanning electron microscopes. Applicants should hold an ONC (or equivalent qualification), have had at least 4 years' laboratory experience and have an interest in electronics and photography; training will be given in electron microscopy.

For suitably-qualified candidate, salary on scale £2,931-£3,336. Applications from recent graduates interested in training in electron microscopy will be considered for appointment against this post; salary for such a candidate during initial training period would be on scale £2,556-£2,724.

Applications giving date of birth, educational qualifications and previous experience should reach the Secretary, University Office, Regent Walk, Aberdeen AB9 1FX, by 27 July, and quote Ref. No. 142/79.

GRADE 6 TECHNICIAN
required to organise running of undergraduate Pharmacology teaching laboratories. Applicants would be expected to make an active contribution to class preparation as well as overseeing the daily and long term needs of the classes. Some experience of staff supervision is essential. HNC, HND, Advanced City & Guilds 735 or equivalent qualification is essential, together with considerable relevant experience. Salary will be on a Grade 6 scale £4,508-£5,282 p.a. (incl. L.W.) 5 weeks holiday plus Xmas and Easter breaks. Appointments subject to a probationary period. Starting date by negotiation.

Applications stating all relevant experience, qualifications and two referees to: Personnel Officer, The School of Pharmacy, 29/39 Brunswick Square, London, WC1N 1AX.

MEDICAL RESEARCH COUNCIL
BLOOD GROUP UNIT
TECHNICIAN
required for general work in blood group serology. The Unit searches for unrecognised blood group antigens and studies the genetical applications of those already known.

Some experience preferred. Applicants should have HNC (Med. Lab. Sciences) or degree. Salary according to age and experience. Apply in writing to Dr. Ruth Sanger, Wolfson House, University College London, 4 Stephenson Way, London NW1 2HE.

LIFE SCIENCE RESEARCH

Life Science Research is a leading contract research company seeking to make a number of new appointments at our Elm Farm Site.

A vacancy has arisen for an experienced animal technician to work with a small team of scientists and technicians in our Acute Toxicology Department.

Work will be mainly with rabbit and small rodent species involved in acute studies and skin and eye irritation work. The successful candidate will be concerned with practical work and with the production of scientific data.

Ideally, applicants will have been studying for I.A.T. qualifications and may already hold a Home Office Licence. Reference JP/1B.

Animal technicians are also required to work in the department of Oncology. These vacancies are suitable for technicians with two to three years experience who may already hold the intermediate certificate of the I.A.T.

The positions involve care and maintenance of rats and mice used for long term testing of drugs, agrochemicals and other novel compounds. Ability to produce neat and accurate scientific data is essential. Reference JP/2B.

Salaries will be commensurate with age, qualifications and experience. Write or telephone for an application form to:

The Personnel Officer,
LIFE SCIENCE RESEARCH,
Elm Farm Laboratories,
Oxcold, Near Eye,
Suffolk.
Telephone: 0379 71 491

M.R.C. CLINICAL RESEARCH CENTRE
(Northwick Park Hospital) Watford Road, Harrow, Middx. HA1 3UJ

TECHNICIAN

with HNC, or **JUNIOR TECHNICIAN** taking HNC, for specialised clinical immunology required in the Division of Immunological Medicine (Head Dr G L Asherson). Opportunities to study for special immunology.
Salary within the range £3,815 to £5,034 incl. L.W.
Application form and further details from Mrs J Tucker-Bull, quoting ref. 118/1/4205. Closing date July 26th 1979.

UNIVERSITY OF EAST ANGLIA
School of Chemical Sciences
POSTDOCTORAL RESEARCH FELLOW

Applications are invited for a post-doctoral research fellowship, tenable for two years, to develop novel organometallic luminescent materials. The work will examine fundamental aspects of energy transfer between a semi-conducting lattice and a discrete organo-metallic centre with a view to designing new materials for use in a range of opto-electronic applications. Experience in the synthesis and spectroscopic study of inorganic or organic materials would be an advantage.

Starting salary on the Research Fellow grade 1A scale with superannuation benefits. Applications, with the names of two referees, as soon as possible to Dr. A. J. Thomson or Dr. M. J. Cook, School of Chemical Sciences, University of East Anglia, Norwich NR4 7TJ, from whom further particulars can be obtained.

MANCHESTER AREA HEALTH AUTHORITY (T) CENTRAL DISTRICT
SENIOR CYTOGENETICIST

The expanding Regional Laboratory which deals with blood, fibroblast and amniotic material is located within the University Department of Medical Genetics. This Department also provides Genetic Counselling and HLA typing services and there is exellent clinical liaison.

Only candidates holding or eligible for an NHS Senior Cytogeneticist post and having extensive experience of Medical Cytogenetics should apply.

Applications with full details of experience and qualifications and the names of two referees should be sent to Dr. Rodney Harris, Department of Medical Genetics, St. Mary's Hospital, Manchester M13 0JH.

BIRKBECK COLLEGE
(University of London)
Department of Geography
RESEARCH ASSISTANT IN HYDROLOGY

Applications are invited for the post of Research Assistant in the Department of Geography from graduates (or students graduating this summer) in an appropriate subject, to work under Dr. I. Reid on problems of water dispersal in clay land soils. Two year appointment from 1st October 1979. Salary within range £4,523-£5,124 inclusive. Further details and application forms from the Secretary, Department of Geography, 7/15 Gresse Street, London W1P 1PA. Closing date 12th July 1979.

Wellcome

Metabolism Chemist

Applications are invited for the post of Metabolism Chemist from candidates with a good first degree in the chemistry or applied chemistry fields and who have relevant analytical experience.

The successful candidate will be involved in the development of analytical methods suitable for the estimation of chemical residues in animal tissues and the supervision of trials designed to determine the depletion rates of such residues. This is an important position and forms part of the residues and metabolism section of the Wellcome Research Laboratories' Chemistry Department.

As a leading pharmaceutical company, we offer an attractive salary and excellent conditions of employment including generous assistance with relocation expenses, where appropriate. The Laboratories are situated in Berkhamsted — a small country town located 28 miles from London (Euston) by train.

If you are interested, please write or telephone for an application form, quoting reference NA9, to

A. J. Morris, Site Personnel Officer,
The Wellcome Foundation Limited,
Berkhamsted, Herts.
Tel: Berkhamsted 3333, ext. 363.

ENERGY

A most exciting field for young chemists

Efficient use of energy resources has emerged as one of the great areas of opportunity. In the field of automotive and industrial lead/acid batteries, we have shown what can be done. Our growth has been strong and consistent. Our current £8 million development programme will ensure that our expansion continues.

In line with this development and expansion, our Automotive Battery Division now need some more of the select few who have the qualifications, skill and enthusiasm to help us to realise our ambitions. And, in the process, develop their own careers.

Naturally, we offer some of the most attractive conditions of employment and remuneration packages.

PROCESS CONTROL CHEMIST

An important appointment calling for a Chemist preferably aged 25/30 with HNC/B.Sc. in Chemistry or Chemical Engineering. This should be coupled with at least three years experience in a Process Industry. Responsibility will be for all Process Control activities in the automotive factory.

SENIOR ANALYTICAL CHEMIST

Will report to the head of the Chemical Laboratory and accept responsibility for the day to day organisation of the department. HNC/B.Sc. in Chemistry desirable plus at least 2 years related industrial experience.

Please write with full details to:

TUNGSTONE

J. C. Duckworth, Personnel Director,
Tungstone Batteries Ltd.,
Market Harborough, Leicestershire. LE16 9EZ.
Tel: 0858 65161

WELSH NATIONAL SCHOOL OF MEDICINE
(University of Wales)

DEPARTMENT OF MEDICAL MICROBIOLOGY

Applications are invited for the post of:

RESEARCH TECHNICIAN

in the above Department to start as soon as possible for work on an M.R.C. — supported investigation on the relationship between herpes viruses and cellular immunity. Applicants should have a minimum of ONC/OND and experience in tissue culture techniques would be advantageous.

Salary on the scale for University Technical Staff Grade 3 starting point up to £3,090 per annum. Further particulars (quoting ref. No. B7/20) available from the Registrar and Secretary, Welsh National School of Medicine, Heath Park, Cardiff, CF4 4XN, to whom applications should be submitted by 13th July, 1979.

UNIVERSITY OF LEEDS

GRADE 5 TECHNICIAN

An experienced Laboratory Technician is raquired immediately for the Department of Obstetrics and Gynaecology (Leeds Maternity Hospital). This Technical work is concerned mainly with immunological aspects of human raproduction and requires knowledge of immunologic mathodologies. The holder of this post is also responsible for the routine supervision of the laboratory, including ordering and checking supplies and equipment. Applicants should possess an HNC or equivalent qualifications and have had about savan years' relevant experience. Salary on the scale £3,474-£4,056 p.a. Applications should be made in writing to Professor J. S. Scott, Department of Obstetrics and Gynaecology (Leads Matarnity Hospital), University of Leeds, 17 Sprinfield Mount, Leeds LS2 9NG.

OPPORTUNITIES IN ELECTRONICS

Broaden your experience by joining our team responsible for electronic support for a large chemistry research department. We tackle anything from D.C. — microwave and tiny micro-circuitry to massive electro-magnets. Interest and initiative are more important than experience as training and the opportunities for further study are available. Salary (Technician Grade 3) in range £3,455-£3,860 inc. of London Weighting. Five weeks' annual paid holiday plus statutory and customary days giving one week at Christmas and Easter. Application form from Personnel Officer (Technical Staff CE24) University College London, Gower St., London WC1E 6BT.

SENIOR COMPUTING ASSISTANT

required in Departments of Agricultural Botany and Applied Statistics, University of Reading, for research project concerned with the collection and analysis of climatic data. The project is sponsored by the Ministry of Overseas Development. The main duty will be to assist in the computer processing of rainfall data. Familiarity with use of computers highly desirable, but programming experience not necessary. The appointment will be until 31st March, 1980. Salary in scale £2,547-£3,369 p.a. (under review). Apply with names of two referees and full details, quoting Ref. TS.43A, to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading, RG6 2AH.

AGRICULTURAL RESEARCH COUNCIL

UNIT OF NITROGEN FIXATION

A vacancy has arisen for a Scientific Officer to work in our Chemistry Department.

The work will involve the development of catalytic systems for the reduction of molecular nitrogen.

The successful applicant will work with a minimum of supervision and after consultation will be required to design new experiments.

Applicants should have a Degree in Chemistry.

Salary in a scale £2,839-£4,415 (under review from 1 April 1979) depending upon qualifications and experience. Non contributory superannuation scheme.

Applications in writing to the Secretary at the ARC Unit of Nitrogen Fixation, University of Sussex, Brighton BN1 9RQ with curriculum vitae and the names of three referees. Closing date: 12/7/79.

MEAT RESEARCH INSTITUTE

SCIENTIFIC OFFICER

A vacancy exists in the Protein Section of the Meat Structure Division.

The project involves the study of enzymes capable of producing a tenderising effect on meat.

The person who fills the post will be substantially responsible for studying the effect of neutral proteinases and should therefore be capable of working independently.

The work will involve protein fractionation techniques and enzymology, and experience in this field would be an advantage.

QUALIFICATIONS: Degree in a relevant subject. Previous experience in protein chemistry and enzymology desirable.

SALARY: £2,839-£4,415. Starting salary depending on qualifications and experience. (Salaries are subject to review).

Permanent, pensionable post.

Application forms and further details from: Personnel Officer, Meat Research Institute, Langford Bristol BS18 7DY.

Closing date for return of application forms: July 12th, 1979.

UNIVERSITY OF EDINBURGH

Grant Institute of Geology

SENIOR TECHNICAL OFFICER

Required to assist with the development of geochemical analytical techniques and with the routine instrumental analysis of geological materials. The equipment available comprises XRF, XRD, electron microprobe, AA (flame and flameless), C-N elemental analyser and a well-equipped wet-chemical laboratory. Routine analytical duties will involve preparation of materials, setting up and operating analytical equipment and the computer processing of data using computer programs already written. The post will involve working with and instructing academic staff and research students. Experience in one or more of the above or related analytical techniques would be an advantage. Qualifications required are HNC or equivalent. Salary on the scale £3,984-£4,758 p.a. (under review) REF: NS259.

Application forms can be obtained from the Personnel Office, University of Edinburgh, 63 South Bridge, Edinburgh EH1 1LS. Telephone 031-556-2830.

ZOOLOGICAL SOCIETY OF LONDON

MICROBIOLOGY TECHNICIAN

Applications are invited for the post of Microbiology Technician in the Department of Veterinery Science. Applicants should have experience of bacteriological and micrological techniques and be willing to assist with identification of parasites. The post offers considerable scope for someone interested in comparative pathology. The salary will be in the range £2,409-£4,080 plus London Weighting £501 depending on age and experience. Applications should be made to the Assistent Establishment Officer, Zoological Society of London, Regents's Park, London NW1 4RY.

QUEEN ELIZABETH COLLEGE, KENSINGTON (University of London)

Microbiology Department

TECHNICIAN GRADE 4

Applications are invited for the post of Technician Grade 4 in this department. Candidates should hold ONC, OND or equivalent qualifications. Although less well qualified persons may be considered.

Salary depending on qualifications and experience within range £3,281-£4,232 p.a. inclusive of London weighting.

Application forms from Mrs. G. Howard, Queen Elizabeth College, Campden Hill Road, London, W8 7AH. Tel: 01-937 5411 ext. 499.

Clinical Trials Database Controller

The Research Institute of Smith Kline & French Laboratories Limited, a major Pharmaceutical Company, presently operates in Welwyn Garden City, but over the next few years will be moving a few miles to newly built laboratories in a rural setting.

The Clinical Research Department has a computerised information system and now needs another person to share the responsibility for the input and retrieval of medical data from clinical trials.

Whilst much of the work is of a routine nature, it calls for a very logical mind and a knowledge of medical terminology since the person appointed will be responsible for ensuring that the information entered is correct. A knowledge of computing or information technology would be desirable, as would the ability to type accurately.

Preference will be given to applicants with an appropriate scientific degree but those with HND or 'A' levels and relevant experience will be given careful consideration.

We offer competitive salaries on progressive incremental scales. Other benefits include a discretionary annual bonus, free Life Assurance, a contributory pension scheme and a growing Sports & Social Club.

Please write or telephone for an Application Form quoting Ref: No. NSC/151 to: Kate Viscardi, Recruitment Administration Officer,
SMITH KLINE & FRENCH LABORATORIES LIMITED
Mundells, Welwyn Garden City,
Hertfordshire AL7 1EY.
Telephone: Welwyn Garden City 25111, ext. 26.

S K & F

a SmithKline company

UNIVERSITY OF SURREY

Computing Unit

SYSTEMS PROGRAMMER

During the summer this year the Department is installing an integrated system of linked Prime computers — the most advanced and powerful multi-access Prime system in Europe.

Applications are invited for the post of Systems Programmer within the Computing Unit and the successful candidate will be expected to work on the development of software for the new system.

The salary will be on the Computer and Other Related Staff Scale up to £7145 (£7521 from 1 October 1979), plus generous annual leave.

Further particulars can be obtained from the Deputy Secretary (Personnel), University of Surrey, Guildford, Surrey, GU2 5XH, telephone Guildford 71281 extension 452. Applications from men and women in the form of a curriculum vitae, including the names and addresses of two referees, should be sent to the same address by 13 July, 1979.

UNIVERSITY OF SHEFFIELD

RESEARCH TECHNICIAN (Grade 3)

Required for the Department of Ceramics, Glasses and Polymers to assist with the development of varied and interesting research projects. Duties will also include the operation, servicing and maintenance of a wide variety of research instruments, together with preparation work in laboratories.

Minimum qualification ONC or equivalent, preferably with chemistry as a main subject.

Salary on scale £2,931-£3336 p.a. (under review).

Please write to the Administrative Officer (Personnel), (Ref. S1234/NS), The University, Sheffield S10 2TN.

THE UNIVERSITY OF SHEFFIELD

Department of Medicine

MAN OR WOMAN BIOLOGY GRADUATE

minimum class II(i), wanted for Medical Research Council Studentship. Those expecting to graduate this summer may apply. A three year award to study for a PhD in respiratory physiology. Project concerns changes in the lung circulation in oxygen deficiency. Apply to the registrar and secretary, the University, Sheffield S10 2TN as soon as possible. Quote Ref: R305/H.

Toxicologists

Huntingdon Research Centre is a contract research organisation working on safety evaluation of pharmaceuticals, biologicals and agrochemicals.

We are seeking both experienced toxicologists and recent graduates who wish to enter this important field. They will join highly professional teams engaged in general toxicological research and should ideally be qualified in biology, zoology, physiology or biochemistry.

Our work is sponsored by companies from many parts of the world and as well as the interest of working with a wide variety of test substances there is the added interest of meeting and communicating with people from other countries.

Salary will be based on experience, qualifications and age. Competitively priced housing is available in several nearby market towns and relocation expenses will be provided by the Centre.

For more information about these vacancies please telephone or write to:

Recruitment Officer,
Huntingdon Research Centre,
Huntingdon PE18 6ES.
Telephone Huntingdon 890431.

HRC

Huntingdon Research Centre

Research Chemist

John and E. Sturge Limited manufacturers a range of fine chemicals at two locations in the UK, and is part of a world-wide pharmaceutical and chemicals group.
As a result of a steady programme of expansion of our research activities, we have a vacancy for a chemist in the Research Department at Selby, in Yorkshire. Our existing product range at Selby is based upon citric acid, citrates and enzymes.
The person appointed will initially concentrate on chemical analysis, including supervision of auto-analyser work. Later, however, activities will widen to include process development for new and existing products, according to the capability of the individual.
Candidates should be aged 21-24, with a good honours degree in chemistry. New graduates would be considered, but one or two years post-graduate experience could be an advantage. Working environment and conditions of employment are attractive, and assistance would be given with relocation where appropriate.

Please write initially for application form to:-
Mrs. B. A. Lungley, Personnel Officer,
John & E. Sturge Limited,
1 Wheeleys Road, Edgbaston, Birmingham, B15 2LE

STURGE CHEMICALS

CHEMIST

A Chemist of degree level or similar with a knowledge of Polymers is required in a development capacity in a well established Company supplying Wax Products to industry.
Initiative, ability and experience in development work is necessary to formulate products to customers' requirements. New Graduates considered. Salary and benefits commensurate with experience.
Apply in writing indicating remuneration required to:-

The Managing Director,
Wilkins, Campbell & Company Limited,
Britannia Works,
The Green,
West Drayton,
Middlesex UB7 7NT

INSTITUTE OF BASIC MEDICAL SCIENCES
SENIOR ANIMAL TECHNICIAN

experienced person, male or female, to be responsible for day-to-day administration of the Animal Unit, and to take part in developing animal health programme.
Salary within Scale £4,701-£6,123 p.a. (inclusive of London Allowance).
Further details and application forms from: Mr. W. F. Davis, Secretary, Institute of Basic Medical Sciences, Royal College of Surgeons of England, Lincoln's Inn Fields, London WC2A 3PN, to be returned by Friday 27 July 1979.

TECHNICAL SERVICE CHEMIST

Cincinnati Milacron Limited require a Technical Service Chemist to work within their Birmingham based Cutting Fluids Division.
The successful candidate will work with a team of qualified Sales Engineers and will be required to provide a complete customer service including laboratory analysis of product samples, technical assistance to customers and visits to users for on-site testing and observation.
Applicants should possess a relevant HNC or Degree qualification and preferably have gained some basic knowledge of engineering processes and/or experience of industrial cutting fluids.
This position carries a salary fully commensurate with the experience and responsibility involved, a company car and first class conditions of employment.
Candidates (male/female) aged between 25 and 40 years are invited to write, outlining relevant career details to date, to:—
I.S. Good, Personnel Officer,
Cincinnati Milacron Limited, P.O. Box 505,
Kingsbury Road, Birmingham B24 0QU.

CINCINNATI MILACRON

CAMDEN & ISLINGTON AREA HEALTH AUTHORITY

WHITTINGTON HOSPITAL

BASIC GRADE BIOCHEMIST

Applications are invited from recent graduates for the post of Probationary Grade Biochemist in the Clinical Biochemistry Department. The Laboratory deals with a wide range of investigations and a comprehensive training in Clinical Chemistry will be provided. The person appointed would be encouraged to study for a higher qualification.
Salary Scale for a 1st or 2nd class honours degree £3,840-£4,629 per annum inclusive.
For further details and application form please contact: The Personnel Department, Whittington Hospital, Highgate Hill, London, N19. Tel: 01-272 9679. Closing Date: Wednesday 10th July 1979.

UNIVERSITY OF SHEFFIELD
RESEARCH ASSISTANTSHIP IN THEORETICAL CHEMISTRY

The University expects shortly to be in a position to appoint a Postdoctoral Research Assistant, with support from the Science Research Council, for work in the general area of quantum chemistry with emphasis on Green's function and density functional methods. Appointment will be on Range 1A at up to £4,910 p.a. Tenable three years subject to annual renewal, from 1 October 1979. Further information from Professor R. McWeeny, Department of Chemistry, The University, Sheffield S3 7HF. Quote ref: R327/H.

Scientific Programmer

Engineering Contracting – London

Davy International (Oil & Chemicals) Limited is a fast expanding member of Davy Corporation Limited, one of the world's largest engineering and contracting organisations.

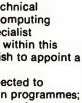
Within the diversified activities of the Technical Operations Department, our Scientific Computing Group is responsible for providing a specialist computing service to the Company. It is within this challenging environment that we now wish to appoint a Scientific Programmer.

The man or woman apointed will be expected to develop scientific and engineering design programmes; assist users of the service, and to make a real contribution to the Group's effectiveness.

Candidates should have a degree or HND in a numerate discipline and have gained — in their earlier education — 'A' levels in Maths, and Physics or Chemistry. Formal training in numerical analysis and experience of scientific programming using Fortran in an engineering problem solving environment is essential.

We offer a competitive salary and the normal range of large company benefits.

Please send a cv or 'phone or write for an application form to Shirley Elen, Personnel Officer, quoting reference TECH 6.



Davy International (Oil & Chemicals) Ltd.
8 Baker Street, London W1M 1DA.
Tel: 01-486 6677
A Davy Corporation company

SUB-EDITOR

Electron, the weekly magazine for the UK electronic and electronics user industries requires a sub-editor.

We are looking for someone who can edit and layout copy at a fast pace.

Ideally, applicants will already have some journalistic experience on a technical publication. However those currently working in electronics who wish to break into publishing will be considered.

Salary up to £4,851 and £210 reading allowance.

Telephone or write to Barrie Nicholson, for an application form: Electron, 79/80 Blackfriars Road, London, SE1 8HN. Tel: 261 9111

IPC BUSINESS PRESS

UNIVERSITY COLLEGE GALWAY, IRELAND

DEPARTMENT OF PHYSICS

Arising out of the introduction of an optional Honours Physics degree in Applied Physics and Electronics, an initial appointment in one of the following specialities is to be made.

(1) **PHYSICIST OR ELECTRONIC ENGINEER** with broad experience in Hardware and Software Computing or

(2) **ELECTRONIC/ELECTRICAL ENGINEER OR PHYSICIST** with experience in Control Systems and/or Micro-Electonics. Industrial experience would be an advantage.

The salary will be in the range £5,000-£8,000 p.a. The appointment will be twelve months and will not be renewable. The College, however, hopes to advertise several appointments in this area in 1980 at either Junior Lecturer (£4,852-£6,706, under review) or Lecturer (£7,220-£9,530, under review).

For further information please contact the Registrar (Telephone Galway 7611, Ext. 192, Telex 8823).

Closing date for receipt of applications is **July 6th, 1979.**

CARDIOTHORACIC INSTITUTE, LONDON

Applications are invited for two posts:-

(1) Postdoctoral

(2) Recent graduate

Appointments supported by a grant from the Multiple Sclerosis Society for a three year period to study mechanisms of cell accumulation and the action of drugs on this process, with particular reference to experimental allergic encephalitis. The work will involve *in vivo* experiments on cell accumulation, utilising isotopic techniques recently developed in this laboratory. The graduate assistant can expect to be involved in extensive animal handling. The graduate appointee would be encouraged to register for a Ph.D. The postdoctoral appointee may be eligible for nomination to a lectureship in Immunopharmacology.

For further information contact Dr. J. Morley on 01-352 8121 Extn. 4194.

Please apply to Mr. R. A. Perkins, Cardiothoracic Institute, Fulham Road, SW3 6HP with details of experience.

Brent & Harrow Area Health Authority **Brent Health District**

Central Middlesex Hospital

Medical Laboratory Scientific Officer

— CLINICAL INVESTIGATION DEPARTMENT

We require either a qualified M.L.S.O. or a B.Sc. Graduate in Medical Sciences to fill the above post shortly to become vacant. Duties cover basic laboratory work specialising in Radio Immuno Assay techniques. Previous experience in this field or within a Biochemistry orientated discipline would be preferable.

Hours: 38 per week.

Salary: Qualified M.L.S.O. £3,615-£5,034 inclusive.

Please contact Mrs. Janice Andrews, Personnel Department, Central Middlesex Hospital, Acton Lane, London NW10 7NS. Telephone: 01-965 5733 ext. 656.

Inner London Education Authority

Science Laboratory Technician Grade 5

required at Henry Compton School, Kingswood, Fulham SW6. Tel: 381 3606. Senior Post. Duties include the supervision of a team of technicians. An up to date knowledge of all equipment used in the teaching of Physics, Chemistry and Biology is necessary as is supervisory and administrative ability. Applicants should have at least HNC/HND, Advanced City & Guilds or equivalent qualifications and a minimum of 8 years experience (including training period).

Salary scale £3474-£4056 plus £525 London Weighting.

Application form and further details available from and returnable to the School within 14 days of the appearance of this advertisement.

Gillette Industries Limited

Senior Scientist Polymer Chemistry

Research and Development Laboratories: Reading

We have a vacancy for an experienced Polymer Scientist to work on the exploitation of novel materials in the field of toiletries and cosmetics as well as on other products of interest to the Company. Applicants, who must be self-starters, must have a good honours degree in Chemistry or Materials Science together with some years' industrial experience in the synthesis of polymers for specific applications. A good knowledge of polymer theory is also required to give an imaginative approach to the problems in hand.

Salary is negotiable dependent upon age and experience and there is a very attractive range of fringe benefits which includes 5 weeks' holiday and generous relocation expenses where appropriate.

If you would like to be considered please contact: D.F. Long, Personnel Officer, Gillette Industries Limited, 452 Basingstoke Road, Reading, Berks. Tel: Reading 85222.

RESEARCH POSTS IN MATHEMATICS AT TEESSIDE POLYTECHNIC

SRC "CASE" Studentships

1. The development and use of finite element software for thermal and structural problems, in collaboration with British Steel.
(Supervisor Dr B A Lewis, SRC grant £1820*p.a. plus British Steel award £500 p.a.).

2. Mathematical modelling of atmospheric pollution, in collaboration with ICI.
(Supervisor Dr A. W. Bush, SRC grant £1820* p.a. plus ICI award £150 p.a.)

*CASE Research Students may undertake paid teaching (if available) up to £500 p.a. In certain circumstances age, experience and dependant's allowances may be paid in addition.

Research Assistantships

3. The affect of surface roughness in elastohydrodynamic lubrication.
(Supervisor Dr A W Bush)

4. Research in abstract algebra : near-ring theory.
(Supervisor Dr A Oswald).

The salary for Research Assistants is £2553, £2664 and £2774 in the first, second and third years respectively and is under review.

Further details are available from: Dr M J O'Carroll, Head of Department of Mathematics and Statistics, Teesside Polytechnic, Borough Road, Middlesbrough, Cleveland TS1 3BA, Telephone: 0642-244176.

Engineer

— Reed Insert Manufacture

GEC Telecommunications Limited has a very modern Reed Insert Manufacturing facility in Coventry, supplying our requirements for large quantity high quality Reed Inserts, used in modern electronic telephone exchange switching systems. This facility has recently expanded to meet increased demand and incorporates the very latest manufacturing technology.
We now have an opportunity for a qualified Engineer, preferably with a Chemistry or Physics Degree background, to join this department. He or she would become involved with investigations and some experimental work concerning the chemical, physical and electrical aspects of the product with some particular emphasis on the problems of glass-metal sealing and gold plating. Experience in electro-plating will be an advantage.
We envisage an attractive salary for this responsible post together with a comprehensive relocation package where applicable.

Persons interested in being considered please write with full career details to Mr P. Boyd, Staff Recruitment Manager, GEC Telecommunications Limited, P.O. Box 53, Telephone Works, Coventry CV3 1HJ.

GEC Telecommunications

ROYAL POSTGRADUATE MEDICAL SCHOOL
Department of Histopathology
MEDICAL LABORATORY SCIENTIFIC OFFICER OR JUNIOR "B" MLSO

Applications are required for this research post, within the Department of Histopathology, investigating various aspects of glomerulonephritis. The work is varied and interesting, demanding initiative, versatility, and a willingness to learn. Cryostat, paraffin and resin sectioning, autoradiography, animal work and immunological studies will be involved.

Previous experience is not necessary, as the candidate will be trained. Appointment is for two years, starting salary up to £3,646 a year (under review).

Further details may be obtained from Dr. D. J. Evans, telephone number 01-743 2030 ext. 219.

Application forms may be obtained from the Personnel Office, Royal Postgraduate Medical School, 150 Du Cane Road, London W12 0HS quoting reference number 6/260.

LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

AERO-ENGINE ALLOYS

Applications are invited for a two year Research Assistantship on an SRC sponsored project investigating thermomechanical processing of superalloys in aero-engine manufacture. Applicants should have a good degree in metallury, production engineering or a related subject and may be eligible to register for a higher degree. Salary within scale £4,232-£5,321. Further details and application form from Dr. Alan Stark, Department of Engineering Production.

Loughborough *Leicestershire*

QUEEN ELIZABETH MEDICAL CENTRE
PHYSICS TECHNICIAN

to help in the survey of X-Ray and radioisotope installations, quality assurance of X-Ray equipment, and a personal dosimetry service. Applicants should possess an appropriate ONC/HNC and a full driving licence. Enquiries are also welcome from those leaving school with 'A' or 'O' levels for appointment at Student or Junior level. Current salary scale (Grade IV) £3,069-£4,134 p.a. (under review).

Further details of the post and an application form are available from Dr. B. L. Reece, Principal Physicist, Regional Radiation Physics and Protection Service, Q.E.M.C. Birmingham B15 2TH (Tel: 021-472 1311 Ext. 316/317 to whom completed applications should be sent so as to arrive by 16th July 1979.

UNIVERSITY COLLEGE LONDON
RESEARCH ASSISTANT

required to assist physical anthropology staff in research and teaching duties. The post will also involve curation of the physical anthropology teaching material collection, routine computer/clerical tasks and assistance in specific research projects. A first degree in a biological science and an interest in physical anthropology/human biology is essential. The successful candidate may be given an opportunity to conduct research leading to a higher degree. Tenable from October 1979. Salary range £3,775-£4,910 plus £502 London Allowance. Applications to Assistant Secretary (Personnel), University College London, Gower St., London WC1E 6BT.

Production Management Potential?

Nestlé is one of the world's largest food manufacturers with 14 factories in the U.K. alone. We require a graduate with a relevant degree and experience who is looking to achieve, after 1-2 years training, a management position at one of our factories.

Initially you will join our Croydon-based Special Assignments team which undertakes projects at any of our factories, thus you must be prepared to spend periods away from home. You should have a degree in Chemical Engineering (although Mechanical or Electrical could be acceptable), with 1-2 years industrial experience (possibly thick sandwich), preferably in the food industry.

If you are interested in a promotion management career and would like to hear more then ring David Carpenter, Personnel Officer on 01-686 3333 extension 2339 or write to him at The Nestlé Company Limited, St. George's House, Croydon CR9 1NR.

Nestlé

GRADUATE ENGINEER

Due to steady expansion and order intake, we are urgently seeking a GRADUATE ENGINEER in our Analytical Systems Design Department.

Our product range includes Oxygen Analysers and Process Gas Chromatographs and high technology Analytical Systems and, therefore, experience in Process Analytical Instrumentation is essential.

The duties involve liaising/advising customers on all technical matters concerning Systems design and specifying/designing sampling Systems to match their requirements.

We can offer a competitive salary, contributory pension scheme, free life assurance and four weeks' annual holiday. Re-location expenses will be paid where applicable.

Please write or telephone for further details to Ron Wordsworth, Personnel Manager, TAYLOR INSTRUMENT ANALYTICS LTD., Jarvis Brook, Crowborough, Sussex. Telephone: Crowborough 2181.

UNIVERSITY OF LIVERPOOL
Department of Oceanography
SENIOR RESEARCH ASSISTANT/RESEARCH ASSOCIATE

Applications are invited for the post of Senior Research Assistant/Research Associate to investigate the finestructure and microstructure of the upper oceanic layers. Candidates should possess a Ph.D. with preferably some experience in numerical modelling. The project is sponsored for three years by the Ministry of Defence at an initial salary within the range £4,776-£6,368 per annum, depending on age and experience.

Applications, together with the names of three referees should be received not later than 1st August 1979, by the Registrar, The University, P.O. Box 147, Liverpool L69 3BX, from whom further particulars may be obtained. Quote Ref: RV/671.

THE POLYTECHNIC: WOLVERHAMPTON
SRC CASE STUDENTSHIP

available for study of deposition/hot corrosion effects in coal-fired fluidised beds, using established combustor facilities. Offers opportunity for collaborative research with the National Coal Board and involvement in an important branch of energy technology.

Applicants should have or expect to have a good Honours degree in Materials/Fuel Technology or Chemistry. Registration with CNAA for a Higher Degree is anticipated.

Application forms and details: "Personnel", The Polytechnic, Wolverhampton WV1 1LY.

Informal enquiries: Dr. R. J. Bishop, Department of Physical Sciences (Tel: Wolverhampton 27371).

UNIVERSITY OF CAMBRIDGE TECHNICIAN

required to work in plant ecology laboratory together with some field work. 32 days holiday p.a. Salary scale £2,770 to £3,146. Please apply in writing to the Department of Applied Biology, Pembroke Street, Cambridge CB2 3DX.

SENIOR RESEARCH MICROBIOLOGIST

The Research Department of the Company requires an experienced Microbiologist to lead a small group involved in the discovery and evaluation of novel agents for the control of industrial microbial contamination.

The Senior Research Microbiologist will develop laboratory test systems using a wide range of appropriate micro-organisms and will arrange and participate in testing under field conditions where necessary.

Applicants should be microbiologists with several years post-graduate experience, preferably in an industrial environment.

The post carries an attractive salary and Company benefits include profit sharing and staff purchase privileges. Generous help with relocation to the Nottingham area is available if appropriate.

For application form write or telephone to:-
T. W. Flower, Employment Manager (Technical), Employment Services Department, The Boots Company Ltd., Station Street, Nottingham. Telephone Nottm. (0602) 56255 Ext. 243.

Boots

THE ROYAL VETERINARY COLLEGE
University of London
Department of Animal Husbandry & Hygiene, Boltons Park, Potters Bar, Herts.
RESEARCH TECHNICIAN

required to assist in a study of nutritional factors influencing reproduction and growth in sheep. The work will primarily involve the assessment of the nutritional value of grassland herbage and the mineral status of the sheep.

Salary according to age and experience in the range £3,032 to £3,982 p.a. (including London Allowance).

Application form obtainable from Assistant Secretary (Personnel), The Royal Veterinary College, Royal College Street, London NW1 0TU (Tel: 01-387 2898 Ext. 264).

CHEMIST

A graduate is required in the Abstracts and Indexes Department of the Chemical Society, based in Nottingham. Duties will involve abstracting and indexing or scientific publications in the field of organic chemistry.
Starting salary from £3,812.

Details and application form from:
Mrs. W. J. Tutty,
UKCIS,
The University,
Nottingham, NG7 2RD.
Closing date: July 20th, 1979.

HOSPITAL FOR TROPICAL DISEASES
PARASITOLOGIST

for training in microscopy and serology in a department which covers all aspects of the diagnosis of parasitic diseases. The post, graded as Scientific Officer or MLSO, would suit BSc or HND graduates. Please apply to the Unit Administrator, Hospital for Tropical Diseases, London NW1 0PE.

YOUNG GRADUATES

The world's largest independent evaluation laboratory devoted to instrumentation is located at Sira. Varied, interesting and challenging work is undertaken for worldwide customers.

Continuing expansion has created vacancies for young graduates with good honours degrees or equivalent technical qualifications in Physics, Electronics or Control Engineering, and Physical Chemistry.

The work involves comprehensive investigations of the performance under controlled conditions of a wide range of process instrumentation for pressure, flow, temperature, viscosity, density, position sensing, chemical composition and other measurements.

Salaries for the above posts will be commensurate with qualifications and experience. Close involvement with staff of other disciplines and unusually extensive contacts with many industrial companies make Sira an ideal scientific community in which either to make a permanent career or to gain experience for career development.

Sira is located in attractive wooded surroundings within easy reach of Central London. Lunches are free; there is a generous pension scheme and an active social club.

Application forms from:

Mrs Jenny Cole,
Sira Institute Ltd, South Hill,
Chislehurst, Kent. (01) 467 2636.

Sira

National Institute of Agricultural Engineering
Wrest Park
Silsoe
Bedford MK45 4HS
Telephone: Silsoe (0525) 60000

HEAD OF CROP ENGINEERING DIVISION

An experienced research ENGINEER or SCIENTIST is required to take charge of a Division with a variety of studies of equipment for rowcrop establishment, sugar beet harvesting, spraying for crop protection and hay drying. The Division has an Operational Research Department which develops mathematical models of agricultural operations to assist the Institute in identifying the important areas for its research and provides a statistical service for the Institute. The Division also contains the Institute's small Central Laboratory providing a wide range of physical, chemical, biological and biochemical services.

The total staff of the Division is 40 of whom 36 are in the Science Group.

The Division can call on the central services in the Institute which include design and construction, instrumentation and computing as well as a library.

Candidates should have a good honours degree and considerable research and administrative experience.

The post is graded Senior Principal Scientific Officer, the salary scale for which is £10,947, £11,631, £12,317 p.a. (£11,449, £12,165, £12,882 p.a. wef 1.8.79).

There is an excellent non-contributory pension scheme.

Application forms obtainable from the Secretary should be returned not later than 31st July 1979.

REF: CED/79/103

SCIENCE MUSEUM

Senior Research Assistant

EDUCATION SERVICE

... to help visitors exploit the educational potential of the collections principally by giving introductory talks and lectures to a wide age range of visitors to interpret the displays and by maintaining a programme of talks on general topics in science and technology. The work also involves preparing non-specialist publications, tape-slide programmes and demonstrations using audio-visual aids.

This post is exempted from the Government's ban on recruitment.

Candidates (aged at least 28) must have a degree with 1st or 2nd class honours or equivalent qualification in a relevant subject and have recent successful teaching experience at least down to lower secondary level. Teaching qualification, industrial and computing and communication experience advantageous. Ability to write clearly on technical matters at an elementary level desirable.

Starting salary between £5,675-£7,420 depending on qualifications and experience.

Salary under review. Non-contributory pension scheme.

For full details and an application form (to be returned by 18 July 1979) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). *Please quote G/5156.*

Central Electricity Generating Board
Research Division
Berkeley Nuclear Laboratories

ASSISTANT TECHNICAL OFFICERS

Berkeley Nuclear Laboratories are situated on the banks of the River Severn midway between Gloucester and Bristol. A number of vacancies exist in the Shielded Area of the Fuel and Core Division for Assistant Technical Officers to operate the remote handling facilities.

The successful applicants will join small teams engaged in the examination of irradiated fuel elements and other components from the Board's reactors. All the posts involve the use of remotely operated equipment including lathes, cutting machines and other specialist rigs.

Duties also include the maintenance of the active facilities and the job holder may be required to wear airline suits, respirators etc.

While it would be preferable for candidates to possess formal qualifications to a minimum of ONC or equivalent, applications from those with sound background in the relevant fields of work will be given equal consideration.

Salary will be in the range £3,570-£5,375 per annum plus a Self Financing Productivity Payment.

Application forms, obtainable from the Personnel Section (telephone Berkeley 451 ext. 308) should be forwarded to the Laboratory Personnel Officer, Berkeley Nuclear Laboratories, Berkeley, Glos., GL13 9PB by not later than July 12 quoting ref. BNL/46/79.

SCIENCE & ENGINEERING GRADUATES

The world's largest independent laboratory devoted to investigations of state-of-the-art process instrumentation is located at Sira.

Continuing expansion has created vacancies for young graduates with good honours degrees or equivalent technical qualifications in Physics, Chemistry, Electrical-Electronic-Control and Mechanical Engineering.

The work involves comprehensive investigations of the performance under controlled conditions of a wide range of process measurement and control instrumentation incorporating the latest techniques including microprocessors.

Salaries for the above posts are up to £7185 p.a. depending on qualifications and experience. Close involvement with staff or other disciplines and unusually extensive contacts with many industrial companies make Sira an ideal scientific community in which either to make a permanent career or to gain experience for career development.

Sira is located in attractive wooded surroundings within easy reach of Central London. Lunches are free; there is a generous pension scheme and an active social club.

Application forms from:

Mrs Jenny Cole,
Sira Institute Ltd, South Hill,
Chislehurst, Kent (01) 467 2636

Sira

CHEMIST Pesticides

We have a vacancy in our Formulation Section for an Experimental Officer to work on the development of novel formulations of herbicides. Applicants should have or expect to obtain this year an honours degree in chemistry and be particularly interested and able in physical, colloid or polymer chemistry. The work will be challenging and involve collaboration with other scientists in the section undertaking fundamental studies and also biologists involved in greenhouse and field studies on these formulations.

The research station is the world-wide centre for pesticide research and development in ICI and is an exciting place to work. The successful applicant will be a member of a higly motivated and successful department concerned with the development of highly effective and environmentally acceptable pesticides for use in agricultural and public-health outlets.

Anyone interested should write immediately to: Mr. S. R. Stephenson, ICI Ltd, Plant Protection Division, Jealott's Hill Research Station, Bracknell, Berks.

ICI Plant Protection Division

SENIOR ANALYST

We are a well-known manufacturer of proprietary pharmaceuticals and toiletry products and are seeking a young man/woman qualified to degree standard in chemistry to be responsible for raw material and product analysis, the investigation of special chemical problems and for analytical development.

Our laboratories are spacious and well equipped in a very modern factory.

We have a pleasant, friendly working environment, a good canteen for low cost lunches and refreshments and a staff shop.

We work a 4½-day week with 4 weeks' annual holiday and are offering around £4,000 per annum to the right candidate.

If this interests you, please contact:
Mr. K. J. Franklin, Chief Chemist, Scott & Bowne Limited, Johnson Street, Southall, Middlesex. Tel: 01-571 2201.

THE LONDON HOSPITAL (WHITECHAPEL)
Department of radiation Physics

MEDICAL PHYSICS TECHNICIAN IV

Applications are invited for the post of Medical Physics Technician Grade IV to join a team providing electronic, technical and scientific support services in radiotherapy. The treatment equipment includes two linear accelerators. A contribution is also expected to the design and development programme of instrumentation for dosimetry and experimental physics.

Salary Scale ranges from £3,423 to £4,488 per annum inclusive, depending on experience and qualifications. Good staff facilities on site. Temporary single accommodation may be available.

Application form and job description available from Personnel — Holland Wing, The London Hospital (Whitechapel), London E1 1BB. Telephone: 01-247 5454, Ext. 388.

Manchester Area Health Authority (T) — South District
WITHINGTON HOSPITAL
Nell Lane, Manchester M20 8LR

SCIENTIFIC OFFICER

Applicants should be Science Honours Graduate. Training offered for routine duties in blood coagulation procedures. Research possibilities.

Enquiries to: The Director, National (UK) Reference Laboratory for Anticoagulant Reagents and Control, at Withington Hospital. Tel: 061-445 8111.

M.R.C. CLINICAL RESEARCH CENTRE

(NORTHWICK PARK HOSPITAL)
WATFORD ROAD, HARROW
MIDDLESEX, HA1 3UJ

We require a PhD PHARMACOLOGIST and a TECHNICIAN with a BSc or HNC. Both with experience in experimental cancer chemotherapy or in evaluating toxicity of antitumour drugs. The work, supported by a national institutes of health contract awarded to Dr G Gregoriadis is related to the use of liposomes in cancer chemotherapy. The appointment will be for two years on a salary scale from £3883 to £6080 p.a. plus £502 L.A.

Application form may be obtained from Mrs J Tucker-Bull, 01-864 5311, Ext. 2685. Please quote Ref. 111/1/2/N.I.H.
Closing date, July 14th, 1979

Department of Biochemistry, UNIVERSITY OF NOTTINGHAM, Queen's Medical Centre, Nottingham, NG7 2UH.

POST-DOCTORAL RESEARCH ASSISTANT

An MRC financed position is available for three years from 1st October 1979 to work on "The Mechanism of Protein Degredation: studies on adipose tissue". A knowledge of Protein Chemistry, protein turnovar or immunochamistry would be advantageous.
Starting salary — £4,232 per annum.
Candidates should write to Dr. R. J. Mayer at the above address.

Medical Equipment Repairman

Saudi Arabia: c£7,500

The Life Sciences Group of the Whittaker Corporation is responsible for the staffing and management of three general hospitals in Saudi Arabia, where the task is to provide a high standard of Health Care in this rapidly developing country.

We now wish to appoint a man with 2/3 years' experience of biomedical electronics who has successfully completed a formal course in biomedical electronic equipment repair.

The benefits package includes free accommodation, life and medical insurance and return air fare. In addition, there are bonuses of around £500 after 6 and 18 months' service and an extra month's salary on completion of the 2 year contract.

Please write with full career details, or telephone 01-584 7639.

Michael Kennedy,
Whittaker Life Sciences Limited,
199 Knightsbridge,
London SW7.

Whittaker
Life Sciences Ltd.

PACKAGING TECHNOLOGIST

COSMETICS AND TOILETRIES

Our wide range of own brand products is backed by first-class technical services. We now have a vacancy for a Packaging Technologist to work in our Consumer Products Laboratories at Beeston, on the outskirts of Nottingham.

We are looking for someone to join a well-established team and to be involved in all stages of package development for a wide range of cosmetics and toiletries.

The man or woman appointed will be a graduate or of similar standing; probably a Member of the Institute of Packaging and will have several years' experience dealing with the packaging of consumer products. Experience in the cosmetics industry would be an advantage. Contact and communication with a wide range of specialists is an essential part of the job.

Conditions of employment are first-class and include excellent pension and profit sharing schemes. Generous relocation if appropriate.

Application forms are available from Tom Flower, Employment Manager (Technical), Employment Services Department, The Boots Company Ltd., Station Street, Nottingham. Telephone Nottingham (0602) 56255 Ext 243.

Boots

RGIT

SCHOOL OF NUTRITIONAL SCIENCE

Senior Lecturers and Lecturers

Honours graduates in Biochemistry, Food Science, Nutrition or Microbiology to teach in BSc and Diploma courses and develop higher level courses.

Research encouraged.
Salary scales in range: Senior Lecturer £7,800-£9,855 per annum. Lecturer £4,422-£8,391 per annum.

Assistance with removal expenses.
Details from Chief Administrative Officer, Robert Gordon's Institute of Technology, Schoolhill, Aberdeen, AB9 1FR. (0224-574511).

FRY

DEVELOPMENT CHEMIST

A development chemist, in his early 20's and with the qualification of HNC or LRIC is required to work on the development and evaluation of surface active organic materials for use in metal joining. This is a new appointment in an established company. Training will be given.

Apply to:
Mr. G. Pascoe, Research Director,

Fry's Metals Ltd
Tandem Works, Christchurch Road,
Merton Abbey, London SW19 2PD.

UNIVERSITY COLLEGE GALWAY, IRELAND
DEPARTMENT OF PHYSICS

Arising out of the introduction of an optional Honours Physics Degree in Applied Physics and Electronics, an initial appointment in one of the following specialities is to be made.

1) Physicist or Electronic Engineer with broad experience in hardware and software computing or

2) Electronic/Electrical Engineer or Physicist with experience in control systems and/or micro-electronics. Industrial experience would be an advantage.

The salary will be in the range £5,000-£8,000 p.a. The appointment will be for twelve months and will not be renewable. The college however, hopes to advertise several appointments in this area in 1980 at either junior lecturer (£4,852-£6,706, under review) or Lecturer (£7,220-£9,530, under review).

For further information please contact the Registrar (Telephone Galway 7611, ext. 192, Telex 8823).

Closing date for receipt of applications is July 6th, 1979.

CRANFIELD INSTITUTE OF TECHNOLOGY
ADVANCED TEACHING + APPLIED RESEARCH

SCHOOL OF MECHANICAL ENGINEERING

SPECIAL OPPORTUNITIES IN ENGINEERING FOR PHYSICISTS AND MATHEMATICIANS

There is a great demand for scientists and mathematicians as well as engineers in the GAS TURBINE INDUSTRY. The Cranfield M.Sc. course in Thermal Power will develop those professional skills required to meet the future needs in research, design and development of both aero and industrial gas turbines, and thus provide opportunities for interesting and rewarding careers. There are excellent facilities for theoretical and experimental research with a particular emphasis on turbo-machinery and combustion.

Entry Qualifications — Funding — A good honours degree is required. The course is approved by the S.R.C. for the award of advanced course studentships.

Accommodation — The Institute's halls of residence are situated on campus and provide individual study-bedroom accommodation. In addition some flats and houses are available for married students.

FURTHER PARTICULARS may be obtained from:
Dr. E. M. Goodger (Ref: NS)
Cranfield Institute of Technology
Cranfield
Bedford, MK43 0AL, U.K.

Portsmouth Polytechnic

M.Sc. in MICROWAVE SOLID STATE PHYSICS

A one-year sandwich/full-time course with a project in industry or the Polytechnic.
Candidates should hold an Honours degree in Physics, Mathematics or Electrical Engineering. SRC Advanced Course studentships may be obtained. Sandwich mode students are normally paid up to £1,000 during their projects in industry.

For further details please write or 'phone to:
Administrative Assistant, Department of Physics, King Henry 1st Street, Portsmouth Polytechnic, Portsmouth, PO1 2DZ.
Portsmouth (0705) 27681 Extension 138.

UNIVERSITY OF LEICESTER
MSc IN EXPERIMENTAL
SPACE PHYSICS

Applications are now being considered for the Space Physics course for entry in October. Candidates should have a degree with 1st or 2nd class honours in Physics, Mathematics or Engineering. The course runs for 12 months and includes lectures, dissertation and project work covering both scientific (astronomy, earth sciences, applications) and technical (propulsion, orbits, communications, etc.) aspects of present-day space research. A number of SRC studentships are available for successful applicants.

Write for further details, including the names and addresses of two academic referees, to Professor K. A. Pounds, Department of Physics, University of Leicester, Leicester LE1 7RH.

EDWARDS SCHOOL OF VACUUM
in collaboration with
ACTON TECHNICAL COLLEGE

present

A One Day Symposium

"HIGH VACUUM TECHNOLOGY"

to be held at the Edward Lewis Lecture Theatre, The Middlesex Hospital Medical School on Wednesday, 11th July, 1979.

The symposium will interest all those concerned with high vacuum and processes involving its use. The subject is treated from its foundations and the aim is to provide practical guidance concerning use and application of pumps, fluids, gauges and analytical and leak detection equipment.

Registration Fee including lunch: £12.50 per delegate.

Further particulars from:
Dr. M. S. H. Rahim,
Symposium Supervisor,
Acton Technical College,
High Street, London, W3 6RD.
Telephone No:
01-993 2344 ext. 2373

M.Sc in R & D at Cranfield

CRANFIELD INSTITUTE OF TECHNOLOGY
ADVANCED TEACHING + APPLIED RESEARCH

The School of Mechanical Engineering at Cranfield offers a course to cater for the needs of engineers who intend to specialise in Research and Development.

The lecture course covers the scientific, technical and management aspects of Research and Development and also industrial instrumentation and experimentation practice.

Half of the course time will be devoted to a project. Candidates sponsored by industry who have a useful development project which they would like to bring to Cranfield will be encouraged to do so.

Candidates should preferably have relevant working experience in addition to their formal qualifications.

For details telephone Dr. R. Reeves (ext. 275) or write to:
The Tutor for Admissions (105)
School of Mechanical Engineering,
Cranfield Institute of Technology,
Cranfield, Bedford,
MK43 0AL, U.K.
Telephone
Bedford (0234) 750111. Ext. 507.
Telex 825 072

On-campus bachelor or family accommodation is available.

BIRKBECK COLLEGE
(University of London)

M.Sc in CRYSTALLOGRAPHY

FULL-TIME or PART-TIME COURSES

with emphasis on the techniques of x-ray analysis, electron microscopy, computer simulation.
Modern Crystallography is concerned with the structure and organisation of composite phase materials, single crystals, macro-molecules, liquids, glasses and disordered systems.
Course options include its application in *Industry* and *Academic Research* in Materials Science, Chemistry, Geology and Molecular Biology.
The course is of interest to Students in Chemistry, Physics, Biophysics, Geology, Engineering and Biological Sciences. It can be taken part-time (about three evenings per week) over two years, or full-time over one year (for which Science Research Council studentships are available).
For further information, please apply to: Professor T. L. Blundell, Department of Crystallography, Birkbeck College, Malet Street, London WC1E 7HX, or telephone 01-580 6822, ext. 284.

STUDENTSHIPS

SCHOOL OF PHYSICS
University of Newcastle upon Tyne
Research Studentships in Geophysics and Planetary Physics

Ph.D. studentships are available for graduates with First or Upper Second Class Honours in either: Physics; Geophysics; Astronomy; Geology; Chemistry or Mathematics.

Current research interests are: Evolution of Planets; Fluid Dynamics; Geochronology; Geomagnetism; Geophysical Electronic Instrumentation; High Pressure Geophysics; History of Earth's Rotation; Palaeomagnetism; Plate Tectonics; Rift Systems; Rock and Mineral Magnetism; Study of Lunar Samples; Submarine Geology; Seismology.

For further particulars, please write as soon as possible, giving personal details, to Mr. J. M. Walmsley, Administrative Assistant, School of Physics, The University, Newcastle upon Tyne NE1 7RU.

UNIVERSITY OF BIRMINGHAM
Faculty of Medicine and Dentistry
Department of Immunology (Rheumatism Research)
SRC CASE STUDENTSHIP

Applications are invited from graduates with a Hons. BSc degree (1st or 2 1) in Biochemistry or Biological Sciences for a 3 year research post starting on 1st October 1979, leading to a PhD degree. The project, in collaboration with the Boots Company Limited of Nottingham, will be concerned with the development and application of a rabbit model of arthritis.

Applications, together with the names of two referees, should be sent as soon as possible to Dr. D. R. Stanworth, Department of Immunology, University of Birmingham, Birmingham B15 2TJ.

University of Oxford
Department of Agricultural Science

Studentship in Environmental Protection

A studentship, established from funds provided by the Thames Water Authority, is available in the late autumn for work on the chemistry of the elements Zn, Cd and Ni in soil. Applicants should possess some chemistry and an interest in the field sciences.

The value and terms of the award are comperable to those of an SRC studentship. Please apply, giving full details and names and addresses of two referees, to the Administrator, Department of Agricultural Science, Parks Road, Oxford OX1 3PF as soon as possible.

SCHOOL OF MECHANICAL ENGINEERING
Cranfield Institute of Technology

SRC RESEARCH AWARD

Forced Convective Cooling of Electrical Equipment

Applications are invited for this studentship sponsored (jointly by the Science Research Council and Cutler Hammer Europa Limited. The student will be required to register for a higher degree, and will work in conjunction with a small research group engaged in the development of advanced techniques for cooling micro-electronic circuits and high-power electrical devices.

The value of this award will be the usual SRC rates +£500 per annum and appropriate incidental expenses will also be paid by the industrial sponsor.

Please contact either Mr. R. Bean or Professor D. Probert at the School of Mechanical Engineering, Cranfield Institute of Technology, Cranfield, Bedford MK34 0AL. (0234 750111 Ext. 577).

UNIVERSITY OF NEWCASTLE UPON TYNE
School of Physics
S.R.C. C.A.S.E. RESEARCH STUDENTSHIP

Applications are invited from persons holding, or expecting to obtain, a good honours degree in physics for a C.A.S.E. studentship in theoretical solid state physics concerning electronic properties of defects in semiconductors, in collaboration with the Royal Signals and Radar Establishment, Malvern.

Further details are available from Dr. M. Jaros, Ph.D., D.Sc. The University, Newcastle upon Tyne, NE1 7RU, to whom applications should be sent along with curriculum vitae and the names of two referees.

UNIVERSITY OF LONDON
KING'S COLLEGE
S.R.C. CASE STUDENTSHIP

Applications are invited from British graduates holding or expecting a Second Class Honours degree in Biochemistry or Pharmacology, or from British students expecting to obtain such a degree this summer, to pursue research on tachyphylaxis in human blood platelets and its relevance to the control of platelet responsiveness. The studentship is held in association with CIBA-Geigy (U.K.) Ltd.

Applications should be sent, as soon as possible to Professor M. C. Scrutton, Department of Biochemistry, King's College, Strand, London, WC2R 2LS.

UNIVERSITY OF READING
Department of Botany
S.R.C. (C.A.S.E.) STUDENTSHIP

Applications are invited from good honours graduates in Plant Sciences for a studentship (in collaboration with the Glasshouse Crops Research Institute, Littlehampton) to investigate the properties of the plant photoreceptor, *phytochrome*, in green plant tissues.

Further information is obtainable from Dr. C. B. Johnson, Botany Department, Reading University, Whiteknights, Reading RG6 2AS, to whom applications should be sent before 13 July 1979.

ST. ANDREWS UNIVERSITY
Physics Department
SRC CASE STUDENTSHIP
DEVELOPMENT OF RARE-GAS HALIDE LASERS

Applications are invited for a research studentship for 3 years in collaboration with Barr and Stroud Ltd., Glasgow. The excimer lasers to be studied produce radiation in the range 193-353 nm at a few hundred millijoules. Applications and requests for further information should be sent to Dr. A. Maitland, Physics Department, St. Andrews University, St. Andrews, Fife, KY16 9SS.

QUEEN ELIZABETH COLLEGE
Kensington
(University of London)
Department of Chemistry

SRC (CASE) STUDENTSHIPS

are available for research in the following areas, leading to the degree of PhD.
(a) Carbohydrate Chemistry. A study of the chemistry of fructose, particularly in relation to the intensely sweet chloro-sucroses. The project is in collaboration with Tate & Lyle Ltd.
(b) Magnetic Resonance. A study of ^{17}I quadrupolar relaxation in sodium myristate and thyroxine derivatives by means of butterfly excitation with up to 1000 MHz. An interest in electronics would be an advantage. The project is in collaboration with Decca Radar Ltd.
(c) ^{14}N quadrupole double resonance. A study of ^{14}N quadrupole double resonance in imidazoles and amidines of pharmaceutical interest. The project is in collaboration with Smith, Kline & French Ltd.

Applicants should possess or expect to gain a first or upper second class Honours BSc. Applications should be addressed to either Dr A. C. Richardson (for e) or Professor J. A. C. Smith (for b and c), Department of Chemistry, Queen Elizabeth College, Campden Hill Road, London W8 7AH.

UNIVERSITY OF READING
Department of Chemistry

CASE STUDENTSHIP

The department has a number of CASE studentships available for candidates with good honours degrees. Topics include General Recovery of Metals using Polymers. Improvement of Properties of Synthetic Elastomers. Investigation of the reactions of C2O and C atoms in the gas phase. Metal Support Interactions in Nickel Catalysts. Properties of Besic Metal Dithiophosphate Complexes. Selective Recovery of Metals from Waste Liquors. Thermodynamic Studies of High Temperature Aqueous Solutions. Tex free stipends range from £1820 to £2550 per annum. Further details can be obtained from Professor H. M. Frey, Chemistry Department, Reading University, Whiteknights, Reading RG6 2AD. (Rtef. M. 45A).

UNIVERSITY OF LIVERPOOL
Department of Dental Surgery
Electron Microscope Unit
A RESEARCH STUDENTSHIP

is available for candidates holding or expecting to gain a 1st or 2(1) honours degree in a biological discipline.

The research programme of the unit is concerned with investigating the utilisation of calcium and other elements in hard tissue forming cells by using electron microscopical analytical techniques.

Applications together with the names of two referees should be received as soon as possible by The Registrar, The University, P.O. Box 147, Liverpool, L69 3BX. Quote Ref: RV/668.

UNIVERSITY OF LEICESTER
Ionospheric Radio Wave Propagation
SRC STUDENTSHIPS

Applications are invited for SRC CASE studentships leading to the Ph.D. degree. The research programme involves basic studies in ionospheric physics, together with investigations of how this medium affects the performance of radio navigation and communications systems. The more applied topics involve considerable use of microprocessors.

Further details of these projects can be obtained from Dr. T. B. Jones, Physics Department, The University, Leicester LE1 7RH.

SRC STUDENTSHIP

Department of Pharmaceutics
Applications are invited from graduates with first class or upper second class honours degrees in pharmacy or related disciplines for an SRC studentship for research in one of the following areas.

Solution properties of surfactants.
Activity of liposomes containing antibiotics.
Cell and tissue culture.

Please write stating interests to Professor A. T. Florence, Department of Pharmaceutics, University of Strathclyde, Glasgow. G1 1XW.

UNIVERSITY OF BATH
School of Pharmacy and Pharmacology
POSTGRADUATE STUDENTSHIP IN BEHAVIOURAL PHARMACOLOGY

Applications are invited from graduates of Pharmacology, Physiology, Experimental Psychology or related disciplines for a research studentship at standard SRC rates.

The work involves investigation of the effects of circadian 'phase-shift' on animal behaviour, and on responses to psychotropic drugs.

Application, together with the names of two referees, in the first instance to Dr. P. H. Redfern, School of Pharmacy and Pharmacology, University of Bath, Claverton Down, Bath BA2 7AY.

Department of Biochemistry, UNIVERSITY OF NOTTINGHAM, Queen's Medical Centre, Nottingham, NG7 2UH.

SRC CASE STUDENTSHIP

A case studentship is available from 1st October, 1979, to work on "Hormonal Regulation of Enzyme Turnover in Adipose Tissue". The project is to be carried out in conjunction with Dr. R. G. Vernon, Department of Physiology, The Hannah Institute, Ayr, Scotland. Candidates should be prepared to work in both laboratories.

Candidates should write to: D. R. J. Mayer at the Nottingham address.

UNIVERSITY OF LANCASTER
Department of Environmental Sciences
RESEARCH STUDENTSHIP

Applicants are sought for an S.R.C. CASE studentship to join a multidisciplinary research group to work for a Ph.D. degree on an investigation of Heavyes Heavy Metal Pollution of Highway Drainage Waters. A background in environmental sciences or chemistry would be advantageous.

Applications including a curriculum vitae should be made as soon as possible to Dr. R. M. Harrison, Department of Environmental Sciences, University of Lancaster, Lancaster LA1 4YQ (Lancaster 65201, ext. 4191) from whom further details may be obtained.

UNIVERSITY OF SOUTHAMPTON

SRC CASE STUDENTSHIP IN TROPICAL ENTOMOLOGY

A CASE studentship, with Shell Research Ltd., is available for work on the chemical ecology of termites and ants, involving field-work in Brazil.

Good honours degree in biological subject required. The successful candidate will be expected to register for a higher degree.

Applications as soon as possible to Dr P. E. Howse, Chemical Entomology Unit, Building 3, The University, Southampton SO9 5NH. Telephone number (0703) 559122 Ext. 2267.

THE UNIVERSITY OF SHEFFIELD
Department of Physics
A RESEARCH STUDENTSHIP (Ph.D)

supported by the N.E.R.C. is available to a man or women for the 3 year period starting October 1979. The project will involve the use of a newly acquired pulsed laser/microscope combination to extract rare gases from geological specimens for analysis in a sensitive mass spectrometer. Applications include the dating of lunar rocks and meteorites and attempts to investigate the release of volatiles from the Earth's mantle and the evolution of the atmosphere. This is a new and exciting technique currently in use in only one other laboratory. Interested students should write as soon as possible to Dr. G. Turner, Department of Physics, the University, Sheffield S3 7RH. Quote ref: R326/H.

THE UNIVERSITY OF LEEDS

DEPARTMENT OF PLANT SCIENCES

Applications are invited from persons who have, or expect to obtain, a first or upper second class honours degree (the course work for which has included the advanced study of plant pathology) for an SRC C.A.S.E. studentship under the supervision of Dr. Alec Carr of the Welsh Plant Breeding Institute and Mr. Tom Preece of the University of Leeds. The project is concerned with resistance to *Xanthomonas graminis* infection in grasses.

Applicatons, with the names of two referees, should be sent to Mr. T. F. Preece, Agriculture Building, The University of Leeds, Leeds LS2 9JT, by 1 August 1979.

ST. ANDREWS UNIVERSITY
Physics Department
M.Sc. STUDENTSHIPS

Industrially sponsored studentships are available for gas discharge laser research leading to M.Sc. degrees.

Applicants should have a first degree at 2ii-level from e British University and should name two referees.

Applications and requests for further information should be sent to Dr. A. Maitland, Physics Department, St. Andrews University, St. Andrews, Fife, KY16 9SS.

UNIVERSITY OF KENT AT CANTERBURY

BIOLOGICAL LABORATORY

Protozoology Research Studentships

Applications are invited from candidates holding a good Honours degree in Biochemistry or a related subject for the following research studentships:
(1) an S.R.C. CASE Studentship in collaboration with Pfizer Inc., Sandwich, Kent and jointly supervised by Drs. R. B. Freedman and W. E. Gutteridge to work on ribosome structure and function in *Trichomonas vaginalis*;
(2) a University Studentship, supervised by Dr. W. E. Gutteridge, to work on ribonucleotide reductase in *Tryptanosoma cruzi*.
Applications should be submitted to the Senior Assistant Registrar, Faculty of Natural Sciences, Chemical Laboratory, The University, Canterbury, Kent CT2 7NH by 16 July 1979. Please quote Ref: PG20/79.

THE UNIVERSITY OF BIRMINGHAM
Department of Plant Biology

Applications are invited for

A POTATO MARKETING BOARD STUDENTSHIP

tenable from 1st October 1979 to study the biochemical basis and genetic control of the non-blackening character in the tubers of *Solanum hjertingii*. The transference of this character to ware potatoes will also be investigated.

Applicants should possess a good honours degree or equivalent and will be expected to register for the degree of Ph.D. The grant will be for three years and will be equivalent to the current SRC awards. Requests for further information and application forms should be made to Professor J. B. Hewich, Department of Plant Biology, University of Birmingham, P.O. Box 363, Edgbaston, Birmingham B15 2TT.

THE UNIVERSITY OF LEEDS

DEPARTMENT OF PHYSICS

S.R.C. Studentship in Physics

Applications are invited from persons holding, or expecting to obtain, a Class I or II(i) Honours degree in Physics for a S.R.C. studentship leading to the degree of Ph.D. in the above Department. The successful candidate will join an active group of polymer physicists working under the direction of Professor I M Ward.

Applications with curriculum vitee end the names end eddresses of two referees should be sent to Professor G J Morgen, Department of Physics, University of Leeds, Leeds LS2 9JT, from whom further details may be obtained.

UNIVERSITY OF NEWCASTLE UPON TYNE
School of Physics
S.R.C. C.A.S.E. RESEARCH STUDENTSHIP

Applications are invited from persons holding, or expecting to obtain, a good honours degree in physics for a C.A.S.E. studentship in theoretical solid state physics concerning electronic properties of defects in semiconductors, in collaboration with the Royal Signals and Radar Establishment, Malvern.

Further details are available from Dr. M. Jaros, School of Physics, The University, Newcastle upon Tyne, NE1 7RU, to whom applications should be sent along with curriculum vitae and the names of two referees.

HERIOT-WATT UNIVERSITY
Department of Pharmacy

CASE Studentship

Applications are invited from persons holding or expecting to hold a good honours degree in Pharmacy or Chemistry for a CASE studentship for research towards the degree of PhD in the following area:
Synthesis of Aromatic and Tricyclic Triazines with potentially useful antidysrhythmic activity, (in collaboration with Abbott Laboratories Limited, Queenborough, Kent.)
The successful candidate will work closely with the industrial collaborators and will spend a period of not less than three months in the industrial laboratories.
Applications with details of career and names of two referees should be sent as soon as possible to: *DrR Grayston, Department of Pharmacy, Heriot-Watt University, 79 Grassmarket, Edinburgh, EH1 2HJ.*

UNIVERSITY OF HULL
Department of Applied Physics
CASE STUDENTSHIP IN ACOUSTIC AND THERMAL PROPERTIES OF GLASS

Applications are invited for a CASE studentship for a research project in collaboration with the Research and Development Laboratories, Pilkington Brothers Limited, to investigate the physical properties of glasses, with particular reference to their application in the field of domestic delay lines. The work will involve the use of ultrasonic, low temperature and thermal expansion techniques together with an involvement in the preparation and manufacture of various glass samples.

The successful applicant should possess an upper second class first class honours degree in Physics, Material Science or related discipline and will be expected to register for a higher degree.

Further particulars may be obtained from either Dr. S. B. Palmer or Dr. R. D. Greenough, Department of Applied Physics, University of Hull, Hull, HU6 7RX, to whom applications, together with the names of two referees, should be submitted as soon as possible.

UNIVERSITY OF BRADFORD

SRC CASE RESEARCH STUDENTSHIP

Candidates who have, or expect to gain, a first class or upper second class honours degree in Chemistry or a related subject, are invited to apply for the 3 year award, in conjunction with Vinyl Products Ltd., to investigate the factors involved in the adsorption of water soluble polymers at solid/liquid interfaces.

Further details/application forms from Dr D Eaglend, School of Pharmaceutical Chemistry, University of Bradford, Bradford BD7 1DP, quoting ref. RS/DE/L.

UNIVERSITY OF NOTTINGHAM MEDICAL SCHOOL
RESEARCH STUDENTSHIP IN MICROBIOLOGY

Applications are invited for a Research Studentship in Microbiology leading to the degree of Ph.D. for work on the continuous monitoring of the action of antibiotics on dense bacterial cultures.

Applications with the names and addresses of two referees to Professor F. O'Grady, Department of Microbiology, University Hospital, Queen's Medical Centre, Nottingham NG7 2UH.

IMPERIAL COLLEGE

DEPARTMENT OF CHEMISTRY

S.R.C./CASE awards from October 1st 1979, are available for suitably qualified graduates in the following areas, with the supervisors and industrial sponsors indicated:

1. Development of modified electrodes for electrocatelysis (Professor W. J. Albery: I.C.I., Mond Div.).
2. Development of Electrochemical sensors for power station water (Professor W. J. Albery: Central Electricity Research Laboratories).
3. Application of microprocessors to electroanalytical techniques (Professor W. J. Albery: Laboratory of the Government Chemist).
4. Alkali-metal peroxy-salts (Drs. W. P. Griffith and A. C. Skepski: Interox Chemicals Ltd.).
5. Absorption of organic molecules in zeolites from liquid-phase solutions (Dr. L. V. C. Rees: Laporte Industries Ltd.).
6. Binary and ternary ion-exchange equilibria and kinetics in zeolites (Dr. L. V. C. Rees: Proctor and Gamble Ltd.).

Applications should be addressed to the supervisors named, at Chemistry Department, Imperial College, London SW7 2AY, as soon as possible: telephone enquiries to 01-589 5111 are welcome.

UNIVERSITY OF HULL
SRC/SSRC RESEARCH STUDENTSHIP IN ECONOMICS

Applications are invited from economics graduates interested in joining an interdisciplinary team studying the prospects and welfare implications of further industrial development along the Humber estuary. The successful candidate will be involved either in the reconstruction of a computable model of the existing industrial complex, or in the evaluation of its output from a welfare-theoretic point of view.

Applicants should hold or expect to hold this summer a first or upper second class honours degree in economics. A background in public/environmental economics or in activity analysis/cost metrics would be an advantage. Registration will be initially for M.Sc. (Econ.), with the possibility of later transferring to Ph.D. Holders of a Master's degree will be considered for direct admission to Ph.D.

Further particulars may be obtained from Professor A. Cigno, Department of Economics, University of Hull, Hull, HU6 7RX, to whom applications containing full educational details and the names of two academic referees should be sent by 29th June.

UNIVERSITY OF BATH
School of Materials Science

SRC CASE STUDENTSHIPS

Applications are invited from honours graduates or prospective graduates in materials science, physics, chemistry or related disciplines for study for the Ph.D. degree over 3 years starting October 1979. Two Science Research Council CASE studentships are available at £2,320 p.a. which includes £500 p.a. supplementary award paid by the cooperating bodies. The research projects are

THE THERMAL CORROSION OF GRAPHITE
to correlate changes in structure of graphites upon gaseous oxidation with strength and fracture properties.

QUANTITATIVE ELECTRON PROBE MICROANALYSIS
to study the physics of x-ray generation by electrons in relation to new quantitative correction procedures using a modern instrument fitted with x-ray spectrometers and energy dispersive analyser.

Further details and application forms are available from Professor B. Harris, School of Materials Science, University of Bath, Bath BA2 7AY. Tel. (0225) 61244, ext. 448.

university of swansea college of

SRC CASE RESEARCH STUDENTSHIP

Applications are invited from persons with a good honours degree in physics, mathematics or engineering or from those expecting to get such a degree, for a **Research Studentship in the Department of Civil Engineering.** The successful applicant will join the numerical methods group and work on a joint project with a leading industrial firm.

The project is concerned with the numerical modelling of the forming, drawing and ironing of thin metal sheet using finite elements. Particular emphasis being placed on the representation of friction, updating of surfaces and constitutive laws.

Application forms and further details may be obtained from the Secretary, Institute for Numerical Methods in Engineering, University College of Swansea, Singleton Park, Swansea, SA2 8PP.

RESEARCH STUDENTSHIP

The Science Research Council is prepared this year to offer to suitable candidates a **Research Studentship** in the **Department of Geology or the Department of Oceanography** at the above University College.

Applicants should have at least an upper second class honours degree in an appropriate science, or be expected to obtain such a degree by July, 1979, in order to pursue a research programme leading to a Ph.D.

The studentship will be tenable from 1st October, 1978 and the value will be in line with current SRC rates.

Further details about the research topics available and application forms may be obtained from the Secretary of the Department of Geology or Oceanography, University College of Swansea, Singleton Park, Swansea, SA2 8PP.

THE CITY UNIVERSITY
Department of Aeronautics
SRC CASE STUDENTSHIP

Applications are invited for an SRC CASE Studentship, tenable for 3 years, commencing 1st October 1979, for research on Flows in Transonic Windtunnels, in collaboration with the Aircraft Research Association (ARA), Bedford. In addition to the standard SRC award a salary and certain expenses will be paid for the time spent at ARA. The research will entail experimental and theoretical investigations to determine the aerodynamic interference effects introduced by transonic windtunnels.

Applicants (male/female) should have, or expect to obtain, a first or upper second class honours degree in engineering or science. Details and application forms from Dr. M. M. Freestone, Department of Aeronautics, The City University, Northampton Square, London EC1V 0HB. Closing date for applications: 20th July 1979.

UNIVERSITY OF NEWCASTLE UPON TYNE
Department of Physiology
S.R.C. C.A.S.E. STUDENTSHIP

Applications are invited from persons holding or expecting to gain a first or Upper Second Class Honours degree in biochemistry or physiology for an SRC CASE postgraduate studentship in the Department of Physiology of The Medical School. The project will study aspects of gastric mucosal protection and in particular the relationship between mucus and bicarbonate secretions.

The studentship will commence on 1st October 1979 and is being carried out in conjunction with the Biological Research Department, I.C.I. Pharmaceuticals Division at Alderley Edge, Cheshire, where the student will spend the industrial period.

Applications should be sent to Dr. Adrian Allen, Department of Physiology, The Medical School, The University, Newcastle Upon Tyne NE1 7RU, tel. 0632 28511.

THE UNIVERSITY OF SHEFFIELD
DEPARTMENT OF
ELECTRONIC AND ELECTRICAL ENGINEERING

SRC CASE and RESEARCH STUDENTSHIP

Applications are invited from graduates, or students expecting to graduate, with a First or Upper Second Class Honours Degree in Pure or Applied Science for CASE studentships in the following topics:

The effect of strain on optical waveguides in the III-V compounds Growth and Transport properties of $Ga_xIn_{1-x}As_yP_{1-y}$.

Growth and transport in alkyl quantum well layers.

Control and properties of amorphous materials and devices.

Input to the body of audio information via peripheral nerves.

A number of SRC quota studentships are also available to enable research in one of the following areas:

Microwave systems and Instrumentation;
Solid state devices and materials;
Microelectronic systems;
Computer-aided design and computer modelling;
Antennas, propagation and optics;
Electrical machines;
Charge coupled devices;
Active devices and circuits;
Medical electronics.

Further details, brochures and application forms can be obtained from **P. N. Robson, Department of Electronic and Electrical Engineering, The University, Mappin Street, Sheffield S1 3JD. Telephone 0742 78555 (extension 5149). Quote ref: R 324/H.**

AGRICULTURAL RESEARCH COUNCIL

ARC RESEARCH STUDENTSHIP

Applications are invited for an ARC Research Studentship tenable for three years from 1 October 1979 at the Letcombe Laboratory for research on the effects of soil conditions on root growth and crop yield. The student will either work on the effects on cereals of water shortage or of waterlogging.

Applicants must have, or be likely to obtain, at least Upper Second Class Honours and will be expected to register for a higher degree.

Further details and application forms from the Secretary, Agricultural Research Council Letcombe Laboratory, Wantage, Oxon, OX12 9JT. Closing date for applications, July 19, 1979.

ROTHAMSTED EXPERIMENTAL STATION
Harpenden, Herts AL5 2JQ

PHYSICS IN AGRICULTURE

ARC Research Studentship from October 1979

Applications are invited from graduates or expected graduates in physical science for an ARC research Studentship. The projects cover aspects of soil water physics and water movement in plants, with reference to the movement and availability of water in agricultural soils.

A first or upper-second class honours degree or an equivalent qualification is required. The successful candidate will be registered with a University for a Ph.D. Applications, giving the names of two referees should be sent by 12th July to Dr. W. Day, Physics Department, from whom further particulars may be obtained.

Ref. 390/3

IMPERIAL COLLEGE

PHD RESEARCH

into new methods of MODELLING RADIATION TRANSPORT

Applications are invited from candidates suitably qualified in physics, applied mathematics or mechanical engineering for 2 research studentships commencing in October 1979.

An SRC CASE studentship is concerned with applying new theoretical developments in the finite element method to the problem of radiation transport in shields. The second studentship is concerned with the important question of calculating radiation shielding requirements of conceptual fusion reactors.

Further details may be obtained from: Dr A J H Goddard, Mechanical Engineering Department, Imperial College, London SW7 2BX, or by telephoning 01-589 5111 ext. 2418.

PORTSMOUTH POLYTECHNIC
Department of Biological Sciences
SRC CASE STUDENTSHIPS

Post 1 Title: The use of tree-rings as a means of dating timbers from historical sites.

Supervisor: Dr. F. A. Hibbert.

Co-operating body: Department of Environment, Ancient Monuments Laboratory, London.

Post 2 Title: Microbial infestation of Diesel fuel storage delivery systems.

Supervisors: Drs. R. A. Eaton and E. B. G. Jones.

Co-operating body: Ministry of Defence, Central Dockyard Laboratory, Portsmouth.

S.R.C. STUDENTSHIP

Post 3 Title: Oogenesis in developmentally retarded tadpoles of Xenopus laevis.

Supervisor: Dr. S. C. Turner.

Title: Some aspects of the biology of the larval stages of digeneans.

Supervisor: Dr. T. A. J. Reader.

S.R.C. ADVANCED COURSE STUDENTSHIPS

M.Sc. Course in the Biodeterioration of Materials.

A number of S.R.C. awards are available for suitably qualified students who wish to apply for the above course.

Starting date for all posts: 1st October, 1979.

Applications to include a curriculum vitae and the names of two referees should be sent to the Administrative Assistant, Department of Biological Sciences, Portsmouth Polytechnic, King Henry I Street, Portsmouth, PO1 2DY from whom further information can be obtained if desired.

Closing date for applications: 5th July, 1979.

LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

RESEARCH STUDENTSHIP

Applications are invited from an SRC CASE studentship for research into the dispersal of atmospheric pollution. The studentship is supported by the CEGB which will be paying a supplementary allowance and the student will join the Central Electricity Research Laboratories at Leatherhead for some months to participate in field work. Candidates should have a good degree in mathematics, physics or engineering and an interest both in mathematical and in physical modelling. The student will be expected to register for a higher degree. Please write giving details to Dr J M Richards, Department of Electronic and Electrical Engineering,

Loughborough *Leicestershire*

QUEEN MARY COLLEGE (University of London)
SRC 'CASE' RESEARCH STUDENTSHIP

Applications are invited for a research studentship, tenable for three years from October 1979, leading to the degree of M.Phil/Ph.D. of the University of London. The project is on the control of amylase production and secretion in yeast and will be jointly supervised by Professor E. A. Bevan and Dr. Noor Evans. It will involve physiological investigations as well as the application of advanced techniques of molecular genetics.

Candidates with, or expecting to gain, a first or upper second class honours degree in an appropriate subject should apply at once to Professor E. A. Bevan, Department of Plant Biology and Microbiology, Queen Mary College, Mile End Road, London E1 4NS, from whom further particulars can be obtained.

THE UNIVERSITY OF LEEDS

THE DEPARTMENT OF CIVIL ENGINEERING AND THE INSTITUTE FOR TRANSPORT STUDIES

Applications are invited from suitably qualified candidates (including those graduating this year) for a number of Total Technology and CASE studentships. Both types of studentship enable successful candidates to work on projects of immediate relevance to industry while registered as M.Phil./Ph.D. students. A balance of lectures in technical and managerial/economic aspects of civil engineering is additionally included in the Total Technology programme.

The range of research topics available includes: damping of noise; PFA concrete; thermal storage in buildings; mechanical splicing of reinforcing bars in concrete; sludge blankets using synthatic membranes; structural adhesive joints, optimising rail facility operation and others in the field of civil engineering (including transport studies).

In eddition, two SRC Collaborative Training Awards are available for students to study for the one-year M.Sc. in Transport Planning and Engineering and to conduct research into public transport essignment programs or factors affecting safety of dalivery transport.

Applications and request for further information should be sent to: Professor A R Cussens, Department of Civil Engineering, University of Leeds, Leeds LS2 9JT.

THAMES POLYTECHNIC
School of Biological Sciences
SRC CASE STUDENTSHIP

Applications are invited for a CASE studentship to undertake an investigation into the role of *Pseudomonas morsprunorum* lipopolysaccharide in canker disease of cherries. The award is tenable from 1 October 1979.

Applicants should hold (or expect to obtain) a good honours degree in biochemistry or chemistry, and if in the latter, should preferably have some experience in microbiology. The investigation will be carried out in collaboration with East Malling Research Station, Maidstone, Kent, and will be jointly supervised by Dr. A. R. W. Smith (Thames Polytechnic) and Dr. R. C. Hignett (East Malling Research Station).

Further particulars and form of application may be obtained from the Staffing Officer, Thames Polytechnic, Wellington Street, London SE18 6PF, to whom completed applications should be returned by 10 July 1979.

LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

Research Studentship

Applications are invited for an S.R.C. CASE studentship for research into the problems, reactions and attitudes of terminal users which may accompany the introduction of computer systems in industry. The studentship is supported by IBM (UK) Ltd, and the student will spend some time at the IBM (UK) Laboratory at Hursley, Hampshire. Candidates should have a good degree in ergonomics or the human sciences. The student will be expected to register for a higher degree. Please write giving details to John Wilcox, Department of Human Sciences.

Loughborough *Leicestershire*

THE UNIVERSITY OF SHEFFIELD DEPARTMENT OF METALLURGY

SRC C.A.S.E. STUDENTSHIPS

Applications are invited from men and women for *ten* SRC/CASE studentships tenable from 1 October 1979 for research in the following fields:

(a) in cooperation with Delta Materials Research Limited, Ipswich "Rheocasting of copper-based alloys"

(b) in cooperation with Firth Vickers Foundry Limited, Sheffield. "Processing and properties of centrispun castings"

(c) in cooperation with Wilkinson Match Limited, Slough. "Formation and properties of some high-strength glassy alloys"

(d) in cooperation with British Aluminium Company Limited, Gerrards Cross. "Stability of solid solutions extended by rapid freezing"

(e) in cooperation with Spring Research & Manufacturer's Association, Sheffield. "Effect of hot prestressing on reduction in spring relaxation"

(f) in cooperation with G.K.N. Group Technological Centre, Wolverhampton. "The influence of texture on fatigue behaviour of steels"

(g) in cooperation with Johnson Matthey Research Centre, Reading. "High conductivity alloys produced by rapid solidification"

(h) in cooperation with C.E.G.B. Marchwood Laboratories, Southampton. "Creep damage at welds under complex stress"

(i) in cooperation with G.E.G.B. Scientific Servlces Division, Gravesend. "Void assessment in materials with changing structure"

(j) in cooperation with B.S.C. Scunthorpe "Mineralogy of sinters made from mixtures of home and imported ore"

Applicants with or expecting good Honours degrees in metallurgy, materials science or related fields should write to Professor G. J. Davies, Department of Metallurgy, University of Sheffield, Sheffield S1 3JD. Quote ref: R.321/H.

University of Reading
Department of Physiology & Biochemistry

SRC Studentship

A three-year SRC Studentship is available from October 1979 to study the neurophysiology and neurochemistry of hypothalamic regulation of luteinising hormone release in the domestic fowl. A good honours degree will be required.

Applicants should send a curriculum vitae and names and addresses of two referees to Dr. R. T. Gladwell, from whom further details can be obtained (0734-85123, extension 7640).

SRC-CASE Studentships in collaboration with the National Institute for Research in Dairying at Reading

1. A three-year Studentship is available from October 1979 to study the hormonal control of lactation in ruminants. Proposed study includes cultural techniques and study biochemical changes during mammary differentiation. Candidates obtained from ruminating a good Honours degree in biochemistry or related subjects will be required. The supervisors will be Professor R. D. Dils (University) and Dr. I. Forsyth (N.I.R.D.).

Applications, including curriculum vitae and names and addresses of two referees, should be sent as soon as possible to Professor R. D. Dils (0734-851212, extension 7600) or to Dr. Forsyth (0734-883103 extension 261) from whom further details can be obtained.

2. A three-year Studentship is available from October 1979 to study nutrient bonding factors in mammary gland and milk. The project will involve the isolation characterization and synthesis of binding proteins for vitamin B12, folate and fatty acids. A good Honours degree in biochemistry or related subjects will be required. The supervisors will be Professor R. D. Dils (University) and Dr. M. Gurr (N.I.R.D.).

Applications, including curriculum vitae and names and addresses of two referees, should be sent as soon as possible to Professor R. D. Dils (0734-85123, extension 7600) or to Dr. Gurr (0734-83123, extension 261) from whom further details can be obtained.

FACULTY OF MANAGEMENT AND INFORMATICS

Department of Computing and Cybernetics

SRC RESEARCH STUDENTSHIP

Applications are invited for an SRC Research Studentship granted to the above Department in collaboration with Quest Automation Ltd. It is proposed to investigate the characterisations and features of handwritten script with the objective of developing a computer system for interpretation of script.

Candidates would normally be required to have or expect to obtain a good Honours degree in computing or other numerate science or its equivalent.

Applications together with the names of two referees should be received as soon as possible by Dr. R. Whitrow, Department of Computing and Cybernetics, Brighton Polytechnic, Mouisecoomb, Brighton, BN2 4GJ. Tel: Brighton 693655, Ext. 2246.

university college of swansea

SRC CASE RESEARCH STUDENTSHIP

Applications are invited from persons with a good honours degree in physics mathematics or engineering or from those expecting to get such a degree, for a **Research Studentship in the Department of Civil Engineering.** The successful applicant will join the numerical methods group and work on a joint project with a leading industrial firm.

The project is concerned with the numerical modelling of the forming, drawing and ironing of thin metal sheet using finite elements. Particular emphasis being placed on the representation of friction updating of surfaces and constitutive laws.

Application forms and further details may be obtained from the Secretary, Institute for Numerical Methods in Engineering, University College of Swansea, Singleton Park, Swansea, SA2 8PP.

RESEARCH STUDENTSHIP

The Science Research Council is prepared this year to offer to suitable candidates a **Research Studentship** in the **Department of Geology or the Department of Oceanography** at the above University College

Applicants should have at least 5n upper second class honours degree in an appropriate science or be expected to to obtain such a degree by July 1979, in order to pursue a research programme leading to a Ph.D

The studentship will be tenable from 1 October. 1979 and the value will be in line with current SRC rates

Further details about the research topics available and application forms may be obtained from the Secretary of the Department of Geology or Oceanography, University College of Swansea, Singleton Park, Swansea, SA2 8PP.

UNIVERSITY OF SOUTHAMPTON
Department of Civil Engineering
RANK MARINE RESEARCH STUDENTSHIP

In recent years a large number of marinas have been constructed, usually on the margin of estuary or river channels. Siltation problems have arisen so that there is a need for research on the nature of the phenomenon and the means of dealing with it, including dredging practices.

Rank Marine International of Port Hamble are sponsoring a postgraduate research studentship, the terms of which are similar to S.R.C. studentships. Both field and laboratory work are envisaged. The research would be eligible for an M.Phil or Ph.D.

For further information and application form, please write as soon as possible to N. B. Webber, The University, Southampton SO9 5NH.

BIRKBECK COLLEGE (University of London)

SCIENCE RESEARCH COUNCIL CASE STUDENTSHIP

BIOCHEMICAL STUDIES OF METAL RESISTANCE IN MICRO-ORGANISMS

RESISTANCE IN MICRO-ORGANISMS

The Science Research Council is prepared this year to offer to a suitable candidate a research studentship tenable under its co-operative Awards in Science and Engineering scheme. The project involves a study of the biochemical basis of the resistance of micro-organisms to metal compounds of medical and environmental interest using a variety of modern biochemical and biophysical techniques.

Applications are invited from those who have, or expect to obtain a first or upper second class honours degree. The project will be supervised by Dr. M. D. Scawen (Centre for Applied Microbiological Research, Porton) and Dr. P. J. Sadler Chemistry Department, Birkbeck College, Malet Street, London, WC1E 7HX (Tel 01-580 6622 ext 326) from whom further details can be obtained

SCHOOL OF CHEMISTRY
CASE AWARDS

Applications are invited for SRC/CASE studentships in the following areas of research:

a. "The Chemistry of Dihalogenocarbene Adducts of Terpenes" under the supervision of Dr. M. S. Baird and in collaboration with Bush Boake Allen Ltd.

b. "Testing of pH glass electrodes at high temperatures" (Dr. A. K. Covington in association with Dr. P. O. Kane, ICI Mond Division, Runcorn, Cheshire). The project will be concerned with the extension of a new method of testing glass electrodes to higher temperatures (up to 130°C). It will provide a good training in industrial use and appraisal of electromechanical sensing devices.

c. "Spectroscopic Studies of Ammonium Uranates". The project, to be carried out with UKAEA as the co-operating body, is designed to develop an understanding of the chemistry of the ammonium uranate system. This understanding will assist the use of ammonium uranate for the removal of uranium from solution. The study will involve spectroscopic studies of ammonium uranates in particular using X-ray photoelectron spectroscopy. Under the supervision of Dr. P. M. A. Sherwood.

d. "The Electrode Kinetics of Electron Exchange Reactions". The project is to study, under the supervision of Dr. J. A. Harrison, the reactions with metal ion complexes, metal deposition and electrocrystallisation phenomena at interfaces using the latest automated equipment. The kinetic information will be used to make correlations and predictions in allied technological fields in conjunction with the International Nickel Co.).

All successful applicants will be registered for a Ph.D. degree and grants will be in accordance with the current SRC Regulations.

Letters of application including the names of two referees should be sent to Mr. S. J. Hall, School of Chemistry, The University of Newcastle upon Tyne, NE1 7RU.

UNIVERSITY OF SOUTHAMPTON
Department of Electrical Engineering
RESEARCH IN POWER SYSTEM ENGINEERING

A CASE Studentship and a CTA (Collaborative Training Award) Studentship are available from October, 1979. Both are sponsored by the Central Electricity Generating Board. The CASE Project is concerned with the current rating and heat transfer in a proposed high power SF_6 gas insulated cable and is in conjunction with The Central Electricity Research Laboratories, Leatherhead, Surrey. The CTA Project is concerned with the development of a realistic model for computing the performance of fast static compensators for inclusion in power system studies and is in conjunction with the Planning Department, C.E.G.B., Sudbury House, London. Several weeks each year will be spent with the sponsors who will augment the basic SRC grant by £750 plus expenses. The successful candidates will be expected to register for a higher degree.

Applications from graduates in Engineering or Physics with curriculum vitae and the names of two referees to Mrs. M. Campbell, Department of Electrical Engineering, The University, Southampton SO9 5NH.

UNIVERSITY OF LONDON KING'S COLLEGE DEPARTMENT OF CHEMISTRY
SRC Research Studentships

Applications are invited for SRC (including CASE) Studentships available from October 1979 in all branches of chemistry leading to the Ph.D. degree. CASE projects include:

Fast-scanning spectrophotometer (Prof. S. F. Mason — Measurement Technology Ltd.); chiral discrimination and enantiomer separation (Prof. S. F. Mason — May & Baker Ltd.); nucleoside synthesis (Prof. C. B. Reese — Roche Products Ltd.); nucleotide synthesis (Prof. C. B. Reese — Glaxo Allenburys Research Ltd.); mechanistic aspects of organo-phosphorus chemistry (Dr. C. D. Hall — I.C.I. Petrochemicals and Polymers Division); polysulphide oil additives (Dr. J. Emsley — Edwin Cooper Ltd.); crystal growth in emulsions (Dr. J. E. Crooks — Shell Research Ltd.); reaction kinetics in emulsions (Dr. J. E. Crooks — I.C.I. Corporate Laboratory).

Applicants should hold, or expect to obtain First or Upper Second Class Honours Degrees from U.K. Universities (or C.N.A.A.) or Grad. R.I.C. of equivalent standing.

Further information and application forms from: Prof. V. Gold, F.R.S., Department of Chemistry, King's College, Strand, London, WC2R 2LS.

IMPERIAL COLLEGE
University of London
DEPARTMENT OF CHEMICAL ENGINEERING AND CHEMICAL TECHNOLOGY

SRC CASE Studentships for research with Dr G C Maitland into the following areas:

1. Elongational flow of polymer solutions in relation to enhanced oil recovery, in collaboration with B P research centre.
2. Mathematical modelling of PVC polymerisation processes, in collaboration with ICI plastics division.

Applicants should hold, or expect to obtain, a first or upper second class honours degree in a physical science or chemical engineering. The awards are tenable for three years at normal SRC rates supplemented by up to £500 p.a. by the sponsors.

All applications, including a curriculum vitae and the names of two referees, should be sent to:

Dr. K E Bett
Department of Chemical Engineering
Imperial College
London SW7 2BY

AGRICULTURAL RESEARCH COUNCIL
STUDENTSHIP

Applications are invited for a studentship to work in the Protein Section of the Meat Research Institute.

The Project is to investigate the turnover and remodelling of the connective tissues in relation to growth and development.

This will consist of radioactive incorporation studies together with autoradiography, the chemical analysis of connective tissue components and an examination of the cellular mechanisms for resorption of tissue.

The project is expected to form the basis for a PhD thesis in the University of Bristol and the appointment will commence in October 1979.

Candidates should possess a First or Upper Class degree in Biochemistry.

Further particulars of the award and allowances together with Application Forms may be obtained from the Personnel Officer, Agricultural Research Council, Meat Research institute, Langford, Bristol, BS18 7DY.

THE CITY UNIVERSITY
SRC (CASE) RESEARCH STUDENTSHIP IN SURFACE SPECTROSCOPY

Applications are invited for a Category A (guaranteed) SRC CASE studentship tenable from October 1979, the title of the project being "The Development of Inelastic Electron Tunnelling Spectroscopy". This is a collaborative project between the Chemistry Department, The City University and Pye Unicam Limited, Cambridge. IETS is an emerging spectroscopy with important applications in surface science and analytical chemistry. It is proposed to study surface molecular interactions using IETS and a wide range of physical techniques, including LEED, Auger Spectroscopy and Electron Microscopy. The successful applicant will gain experience in electronic design and development, vacuum technology and solid state chemistry. Applicants should have, or expect to obtain, a First or Upper Second Class Honours Degree in Chemistry, Physics, Materials Science or Electrical Engineering.

Applications with the names of two referees should be sent as soon as possible to B. O. Field, Department of Chemistry, Northampton Square, London EC1V 0BN (01-253 4399 ext. 547) from whom further details may be obtained.

ION EXCHANGE AND DETERGENCY

A three year Research Studentship is now available, starting 1st October 1979, for studies on the fundamental principles of ion exchange in zeiolite aluminosilicates, with particular reference to their importance in detergency. The successful applicant will gain experience especially in the fields of analytical and physical chemistry, computer modelling and instrumental techniques. The project is co-sponsored by the S.R.C. and Unilever Research (under the CASE scheme) and applications, together with a brief curriculum vitae and the names of two referees, should be sent as soon as possible to Dr. R. P. Townend, Department of Chemistry, Northampton Square, London EC1V 0HB.

FELLOWSHIPS GRANTS AND SCHOLARSHIPS

UNIVERSITY OF NOTTINGHAM
Institute of Planning Studies
SOCIAL RESEARCH AND COAL ENERGY FUTURES
(Readvertisement)
RESEARCH FELLOWSHIP/ ASSISTANTSHIP

£3,689-£4,776

Applications are invited for the above post to work on a project commissioned by the SSRC Energy Panel on "Social Science Research Requirements for Alternative Coal Energy Futures" under the direction of Mr. D. Cope and Dr. P. Hills.

Applicants should be interested in the relationships between social science research and environmental and technological factors. A knowledge of the general issues raised by long-term energy policy in Britain would be particularly appropriate. Disciplinary background will be of less significance than the ability to synthesise and evaluate material drawn from a wide range of sources. A higher degree and/or recent research experience would be preferred.

The appointment will be for 12 months, commencing as soon as possible.

Further details and forms of application, returnable not later than

from:

Telephone (0602) 56101 ex. 3302 or Dr. P. Hills,
Institute of Planning Studies,
University of Nottingham,
University Park,
NOTTINGHAM NG7 2RD.
Telephone (0602) 56101 ex. 3302 or 3063.

Previous applicants need not re-apply.

NUFFIELD FOUNDATION

ONE-YEAR SCIENCE RESEARCH FELLOWSHIPS

The Nuffield Foundation is offering to University Lecturers in Science (but not Mathematics) Departments a number of one-year research fellowships to be awarded competitively at the end of 1979 and to be held during the academic year 1980-81. The objective is to enable younger university lecturers to be freed from teaching and administrative duties for one academic year in the first instance; preference will therefore be given to applicants under the age of 40. Awards will cover the cost of replacement teaching and will include an allowance for research expenses.

The closing date is 15 October 1979 and further particulars may be had from the Director, Nuffield Foundation, Nuffield Lodge, Regent's Park, London NW1 4RS.

IMPERIAL CANCER RESEARCH FUND

RESEARCH FELLOWSHIP

A Post-Doctoral Biochemist or Molecular biologist with experience in DNA sequencing techniques is required to assist in cloning and to sequence biologically significant regions of higher eukaryotic DNA.

The appointment will be for three years. Salary range £5,823 to £7,129 inc. LA.

For further information telephone Dr. M. Fried (01-2420200, ext. 297).

Applications with curriculum vitae and the names of two referees should be sent to the Secretary, Imperial Cancer Research Fund, Lincoln's Inn Fields, London WC2, quoting Reference 301/79 by 30th July 1979.

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IMPERIAL CANCER RESEARCH FUND

RESEARCH FELLOWSHIP

We have a vacancy for a postdoctoral Research Fellow to join a group working on ageing and neoplastic transformation in epithelial cell systems *in vitro*. Special experience in cell culture techniques, cell hybridisation, etc. an advantage.
Appointment will be for three years. Salary according to qualifications and experience. Further information from Dr L. M. Franks (01-242 0200 ext. 211). Applications with curriculum vitae and names of two referees should be sent to The Secretary, Imperial Cancer Research Fund, Lincoln's Inn Fields, London WC2A 3PX.

UNIVERSITY OF WARWICK
Mathematical Modelling of Clinical Trials
RESEARCH FELLOWSHIPS

Applications are invited for two posts of Senior Research Fellow in the newly-established Research Centre for the Mathematical Modelling of Clinical Trials. Appointment will be for a period of three years from October, 1979. The successful applicants will form part of a team of OR researchers working with research clinicians to develop mathematical models of patient progress for particular cancers, using new methodologies. An interest in the broad areas of mathematical modelling, use of computers, cancer research, etc., may be advantageous. Salary within the Research Range II scale £6,627-£8,452 p.a. Further particulars and application forms from the Academic Registrar, University of Warwick, Coventry CV4 7AL, quoting Ref. No: 46/3A/79. Closing date for receipt of applications is 20 July 1979.

UNIVERSITY OF EXETER
Chemistry Department
Structural Studies of Liquid Crystals

Applications are invited for a POSTDOCTORAL RESEARCH FELLOWSHIP to work with Professor A. J. Leadbetter on X-ray diffraction studies of smectic liquid crystals. Crystal structure determinations of the crystalline precursors and some neutron scattering work might also be involved depending on the interests and experience of the person appointed. Applicants may be chemists or physicists and some experience of X-ray diffraction and computing would be an advantage, though not essential.
The post is tenable for one year in the first instance with the possibility of renewal for a further year. Starting date by arrangement on or after 1 September 1979 at a point on the salary scale commencing at £4,333 p.a., depending on age and experience.
Applications should be sent as soon as possible to Professor A. J. Leadbetter, Department of Chemistry, Stocker Road, Exeter.

LEICESTER UNIVERSITY
Primary Communications Research Centre
DIRECTOR

Applications are invited for the above post to be supported by a grant from British Library (R & D) Dept. The person appointed will preferably have some experience both of research and of an appropriate area of primary communications (e.g. scholarly publishing).
Salary will be on Range III of the scale for Research and Analogous staff. Salary scales at present: £8,182 to £10,097 (with Agreed Scales at £8,698 to £10,775 and subject to further review expected to be effective from 1 October 1979).
The appointment will date from 1 October 1979 or as soon as possible thereafter.
Further particulars and forms are available from Professor A. J. Meadows, Primary Communications Research Centre, University of Leicester, Leicester LE1 7RH, to whom applications must be returned by 13 July.

GERMAN POSTDOCTORAL FELLOWSHIPS IN MOLECULAR GENETICS

Applications are invited for posts in our Department of Molecular Genetics. Applicants should be holders of a Ph.D. in microbiology, in genetics, or in virology. Preference will be given to persons having sound biochemical background with experience in protein and nucleic acid analysis by techniques (electrophoresis, hybridization, recombinant DNA techniques, cloning).
Duration: 2 to 3 years, possibly permanent.
Salary: dependent on qualifications and experience according to BAT.
Applications, including curriculum vitae, a list of publications, and the names of two referees, should be sent to:
Prof. H. H. Hoffmann, Abt. F. Molekulare Genetik der Gesellschaft für Strahlen- und Umweltforschung, 3400 Göttingen, Grisebachstr. 8, Federal Republic of Germany.

UNIVERSITY OF WARWICK
RESEARCH FELLOW

Applications are invited for a S.R.C. post-doctoral research fellowship, for one year starting as soon as possible, to work with Professor E. F. W. Seymour in the Department of Physics on the diffusion of hydrogen in transition metals using pulsed field gradient nuclear magnetic resonance. Salary will be at not higher than point 3: £4,776 p.a. on the Range 1A Scale £4,232-£7,145 p.a. Further particulars and application forms from the Academic Registrar, University of Warwick, Coventry CV4 7AL, quoting ref. 46/A/79. Closing date for receipt of applications 31 July 1979.

APPOINTMENTS WANTED

CO- ORDINATOR
Previous experience in the contracting industry. Currently managing projects associated with the development of domestic heat pumps for the UK market.
Similar position in a progressive company required.
Replies to Box No. D393.

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Ariadne

■ For some reason I missed the recent attack made on farming operations by Marion Shoard, a research fellow at the Centre for Environmental Studies. She said, if I am summarising correctly, that landscape was being ruined, unique communities of plants and animals being destroyed, rough land previously open to the public being taken over by the plough.

The worst feature of these processes was, she said, that farming operations are free from town or country planning restrictions; if we want to preserve the countryside, we should change this and farmers should have to apply for planning permission if they want to do anything drastic.

As I missed all this originally, perhaps I have also missed the farmers' reply, though I can imagine what it was. I don't think that Miss Shoard will be encouraged by another recent talk, this time by John North, of the Agricultural Development and Advisory Service. He was extolling the virtues of computers on farms, in, I must say, the somewhat tortured language that seems to grab many speakers by the larynx. Mini-computers, he said, at the Beccles Artificial Insemination Centre's AGM, could be applied "in the whole farm business situation . . . records and accounts, stock control and whole farm planning are all obvious candidates." It's notorious that computers hardly ever take into account such things as delight, convenience, intangible values, birds, badgers or banks where wild thyme grows.

■ Scientists haven't had such a bad time of it in the last thirty years, really, as people with prestige. It was always on the cards that the pendulum would swing the other way and from being considered thaumaturges they would find themselves put down as dangerous mountebanks. I don't know where the pendulum is on its swing at the moment, though I suspect that it's on the way back and science and scientists will become valuable and respectable again. Optimism is all.

But there is one place where scientists have never lost their reputation and that's in advertisements. At the week end I was looking at an announcement for orthopaedic beds. What was that staring at me from the left hand top corner? A man in a white coat, wearing thick-rimmed glasses. On TV, the man who recommends anything technological is dressed in a white coat, too, unless he is Sir Robert Mark. A powerful prop, I have observed, is a top pocket so lined with pens that it looks more like a fence.

Once you start searching for the man in the white coat, you will find him in evidence all over the place. He is, however, somewhat expressionless. He has only two faces, one of sincere pleasure at being able to offer what he is offering and the other of grim warning of what might happen if you don't take it up.

■ Murray Spiegel, of Harvard University, has been telling the Acoustical Society of America about his experiments to find out whether or not musicians are better listeners than other people. He cites Toscanini as being famous for throwing out players who produced a wrong note, being able to hear it through the ensemble of an entire symphony orchestra. Toscanini, as anyone who is interested in jazz will know, is not alone. Benny Goodman has just as acute an ear. The Goodman "ray", the stare that he turned on a member of his band who played a clinker, is notorious among jazz musicians.

Spiegel used patterns of tones, in pairs, and for half of the time of each test, the second pattern had a minute change in pitch. It could be anywhere in the pattern, so that people could not expect it.

Even musicians found the tests taxing, but they could detect smaller changes in the patterns than the others could. On the other hand, students trained on the tests for a matter of months were better at the job than players from the symphony orchestra in question, the St Louis Symphony.

The conclusion seems to be that extensive training is "a large component of how well non-musicians and musicians listen to complex sounds". Whatever will be discovered next, I ask?

■ My pyrochoral friend Daedalus has been pondering the strange phenomenon of explosion-limits in gases. A hot mixture of gas and air can react flamelessly to combustion products. As the pressure is raised, the rate of reaction increases and ultimately becomes explosive. But a further rise in pressure can quench the explosive chain-reaction and restore slow flameless combustion. So Daedalus is devising an explosion-limit sonic amplifier. It is essentially a red-hot speaking tube fed with an appropriate gas-mixture. In the absence of sound, internal flameless reaction keeps it quietly hot. But an entering sound-wave raises the reaction-rate at its pressure-peaks and depresses it at its pressure-troughs. Energy is released selectively into the peaks, raising their relative pressure still further and so amplifying the sound as it goes down the tube. The whole thing is kept from exploding uncontrollably by the upper explosion-limit of the gas. As the sound-peaks transiently reach this pressure, the reaction is quenched and the sonic pressure stabilises. So the tube is a splendid chemical hi-fi amplifier whose gain can be governed by adjusting the composition of the feed-gas to vary its explosion-limit.

The obvious use of this elegant new technology is to revive the phonograph, which with a red-hot gas-fed speaking trumpet could rival the loudest of electronic amplifiers. Similarly, a combined flameless central heating and speaking-tube intercom system might appeal to owners of vast, draughty ancestral homes. But Daedalus sees his amplifier with its enormous gain as a new internal-combustion engine. His prototype car has a long trombone-like tube wrapped around it, with a conventional piston and crankshaft in the bell. Fuel-air mix is fed into the tube, and a signal-generator at the "mouthpiece" injects the sound which, vastly amplified, drives the piston at the same frequency. All the complexity of tappets, sparking-plugs etc, is avoided. And musically talented drivers could even dispense with the signal-generator, and control their cars by singing to them.

Spiders

E.O. Wilson: Let me remind you that people everywhere, a large percent of the population, at a very early age have already developed a deep horror at the sight of snakes or spiders with nothing more than gentle nudging from their parents, if that. Yet, in spite of the fact that parents constantly reinforce their children against going near electric sockets, automobiles, knives and the like, phobias against such objects rarely develop.

Marvin Harris: Let's go back again to the possibility that these phobias are genetically programmed – which I'm willing to grant. The overwhelming bulk of the socially conditioned response repertories of different human societies consists, by your own admission, of culturally determined rather than genetically determined traits. Then it seems to me that when one offers a cogent culturological explanation of these ph... has to be considered that thi... offered in iso...

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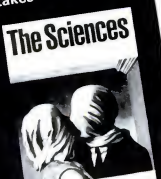

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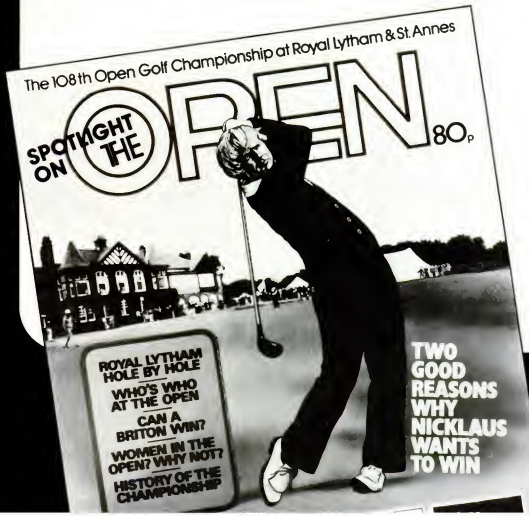

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